PUBLIC LIBRARY OF THE CITY OF DETROIT.

$4.00 per Year. JUNE 4, 1908. Price 10 Cents

AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY,

Vol. 31. 505 PEARL STREET, NEW YORK. No. 23.

Index to Advertisers and Classified Index Following Reading Matter.

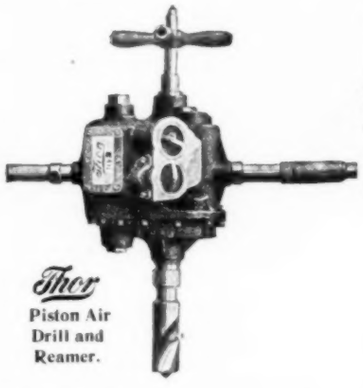
Air Thor Tools

ARE INCOMPARABLE

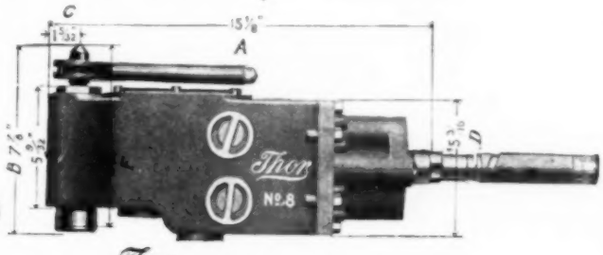
Their Superiority is attested by the fact that a majority of the largest and most progressive plants throughout the world have adopted them as the standard after exhaustive competitive tests.

They have no delicate mechanism, are easily handled and operated, and their use brings results no other air or electric tools can hope to equal.

POWERFUL



Thor Piston Air Drill and Reamer.



Thor Close-Quarter Piston Air Drill
Can be operated within 1 5-32" of a corner.
The most successful drill of its kind yet produced.

SENT ON 30 DAYS' TRIA
Express charges paid
if not sati

ECONOMICAL

Thor Breast and Screw Feed Drill

EFFICIENT

Thor Chipping and Calking Hammer.
Equipped with Duplex Valves

Catalog Mailed On Request

DURABLE

No coupling between barrel and handle

Thor ONE-PIECE Riveting Hammer
Made of ONE SOLID PIECE OF DROP FORGING
Practically Indestructible.

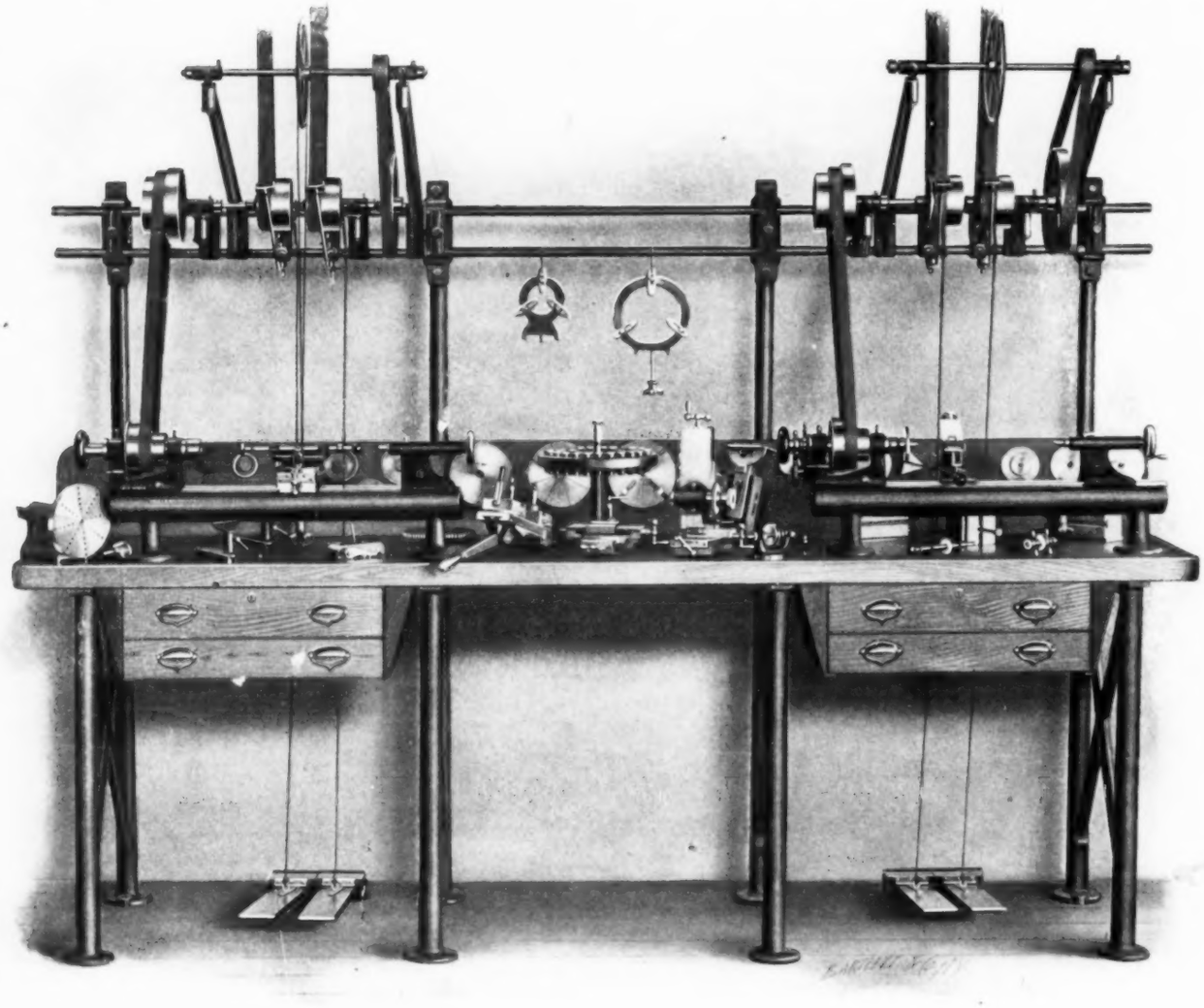
INDEPENDENT PNEUMATIC TOOL CO.

MANUFACTURERS OF
Piston Air Drills, Reaming, Tapping and Grinding Machines, Reversible Flue Rolling and Wood Boring Machines, Pneumatic Riveting, Chipping Calking and Beading Hammers, and Air Appliances of every description.

General Offices: First National Bank Building, CHICAGO
Branch Offices: 1426 Farmers Bank Building, PITTSBURG, PA.
Eastern Offices: 170 Broadway, NEW YORK CITY
61 Fremont Street, SAN FRANCISCO, CAL.

BENCH LATHES

Showing Method of Installation



A precision machine for experimental and jig work, embodying accuracy, convenience and such universal features as filing, threading, milling and grinding attachments, compound slide rest, etc.

The operation of the bench lathe is extremely simple, construction is rigid and repair work on it is greatly simplified by the interchangeability of the various parts.

Fifty-two of these Machines in constant use in our Hartford works.

For Heavy Machine Tools see pages 35, 36, 37 and 38.

PRATT & WHITNEY COMPANY,
HARTFORD, CONN., U.S.A.

OFFICES—Trinity Building, 111 Broadway, New York. Boston: Oliver Bldg. Chicago: Commercial National Bank Bldg. Pittsburg: Frick Bldg. St. Louis: 516 North 3d St. Philadelphia: 21st and Callowhill Sts. Birmingham, Ala., Brown-Marx Bldg. Agents: California, Nevada and Arizona, Harron Rickard & McCone, 436 Market St., San Francisco, Cal., and 164-8 North Los Angeles St., Los Angeles, Cal. The Canadian Fairbanks Co., Ltd., Montreal, Toronto, Winnipeg and Vancouver. Japan, F. W. Horne, 70 C Yokohama.

From The Smallest Screw To 4½ Bar

Style "D" Self-Opening Adjustable Die Heads

A good head for cutting any length screw right or left hand and of any standard or special pitch.

The self-opening feature saves time in running back and protects the screw from stripping.

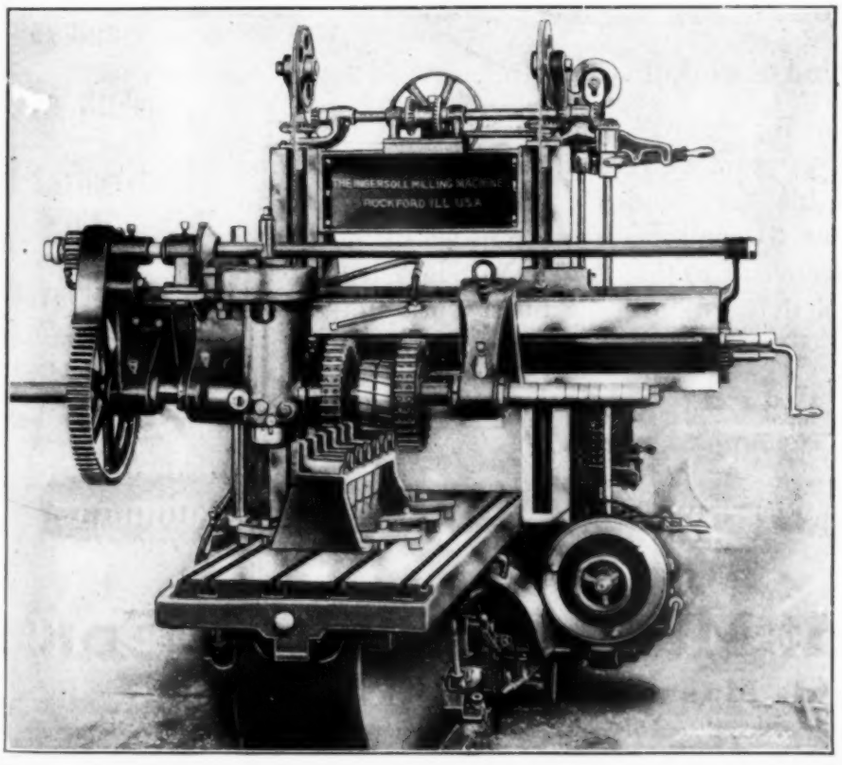
Let us estimate the saving of our Tools for your shop.

The Geometric Tool Company,

New Haven, Connecticut, U. S. A.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Glasgow and Newcastle-on-Tyne. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan and Bilbao. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg and Stockholm.

COMBINATIONS OUR SPECIALTY



See that Vertical Spindle ready for use when the job for the horizontal runs out—our *22 years* in Milling Machines (light and heavy) exclusively—enables us to propose and furnish the right combination of spindles for each customer.

Send in your requirements.

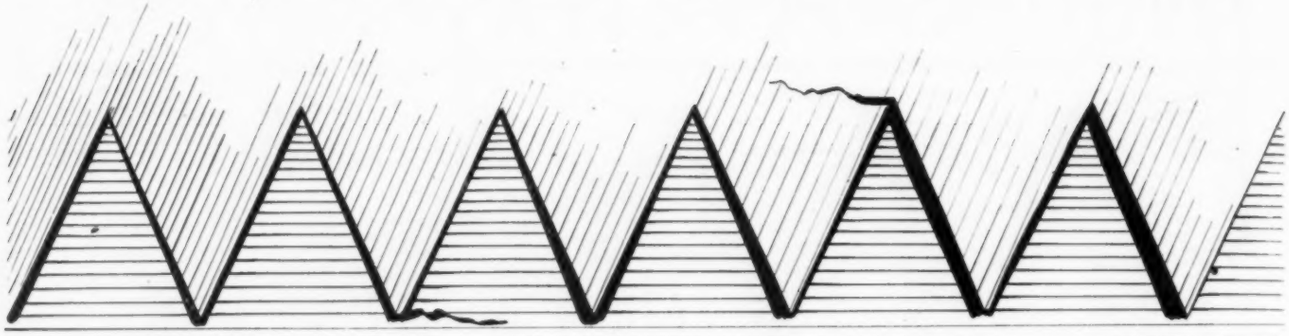
THE INGERSOLL MILLING MACHINE CO.

ROCKFORD, Ill., U. S. A.

New York Office, 50 Church Street
WALTER H. FOSTER CO., Managers

C. W. BURTON, GRIFFITHS & CO., London, E. C.
KRETSCHMER & CO., Frankfurt-on-Main, Germany
ANDREWS & GEORGE, 342 Yokohama, Japan

Unequal Strains That Strip Threads



Are Unknown Where Only

Card Taps

And Dies Are Used

Card Taps are perfect in temper, proportion, design, trueness and accuracy.

When a hole is threaded with a Card Tap, you can rest assured it is standard, clean, smooth, accurate and uniform —*clear down.*

That's the kind of work that pays!

The reasons for "Card" Supremacy are simple but *convincing.* For 34 years we've been making Card Taps from the finest procurable steel, tempered just right. Our superior knowledge of how to combine *ideal qualities* in a tap has enabled us to turn out taps that are HONESTLY better than all others. Taps that produce the finest work and give the longest service.

Card Catalog?

S. W. Card Manufacturing Co.,

Mansfield, Massachusetts, U. S. A.

New York Store, 132 Liberty St. *Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow.*

NILES

CRANES

Capacity
2 to 200 Tons

Separate motor drive for each travel of crane.

Write for Catalog
"NILES ELECTRIC TRAVELING CRANES"

HOISTS

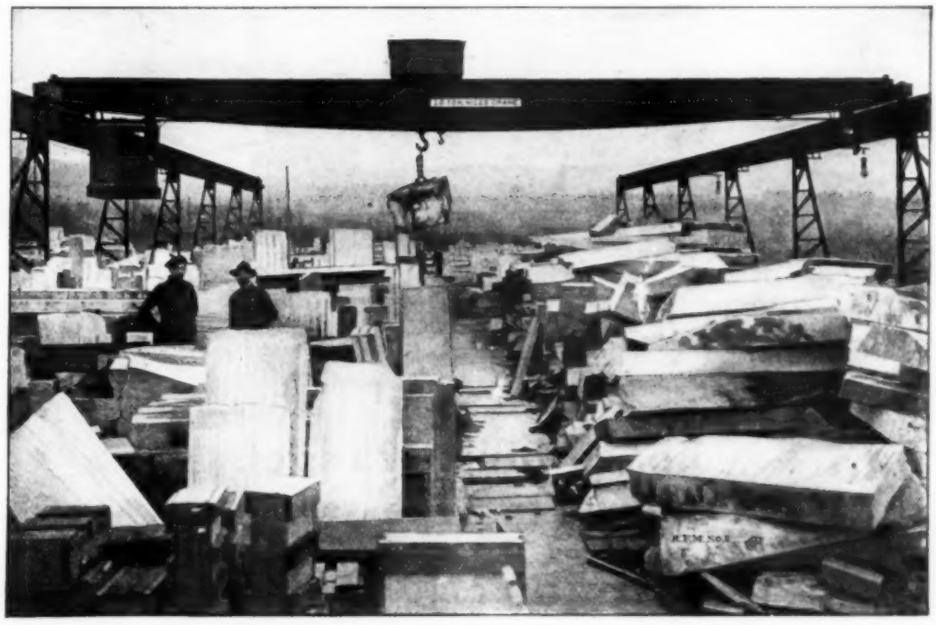
Capacity
¾ to 6 Tons

Hoists equipped with mechanical load and electric brakes.

Write for Catalog
"NILES ELECTRIC TRAVELING HOISTS"

Two Niles 5-Ton Jib Cranes, 12 foot reach. American Locomotive Co., Schenectady, N. Y.

Box Girder
—
Plate Girder
—
I Lattice Girder
—
Movable Jib
—
Walking Jib



Traveling Wall
—
Fixed Gantry
—
Traveling Gantry
—
Pillar
—
Special Cranes

20-Ton Niles Electric Traveling Crane. 80-foot span with 5-Ton auxiliary hoist. Rutland Florence Marble Co., Fowler, Vt.

NILES-BEMENT-POND CO., TRINITY BUILDING, 111 BROADWAY, NEW YORK, U. S. A.

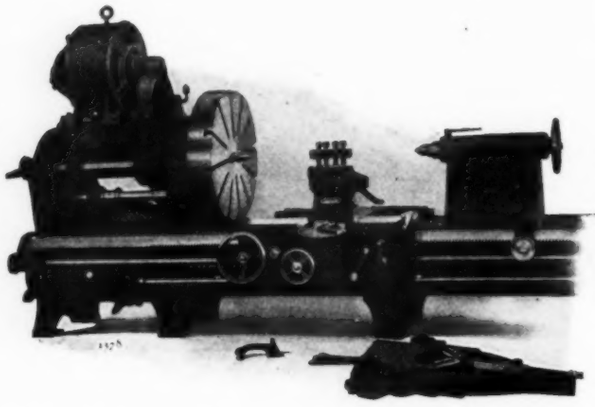
OFFICES:

Boston: Oliver Bldg. Chicago: Commercial National Bank Bldg. Pittsburg: Frick Bldg. St. Louis: 516 North 3d St. Philadelphia: 21st and Callowhill Sts. Birmingham, Ala: Brown-Marx Bldg. Agents: The Canadian Fairbanks Co., Ltd., Montreal, Toronto, Winnipeg and Vancouver. Agents for California, Nevada and Arizona: Harron, Rickard & McCone, 436 Market St., San Francisco, Cal., and 164-8 North Los Angeles St., Los Angeles, Cal. F. W. Horne, 70 C Yokohama, Japan.

Machine Tools of

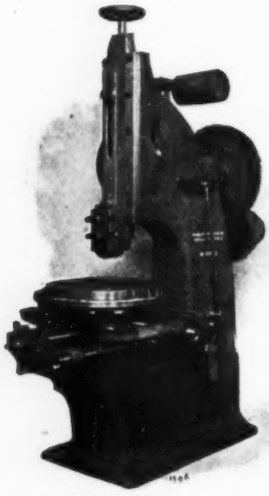
From the Little Bench Lathe

Electric Cranes
2 to 200 tons
capacity.

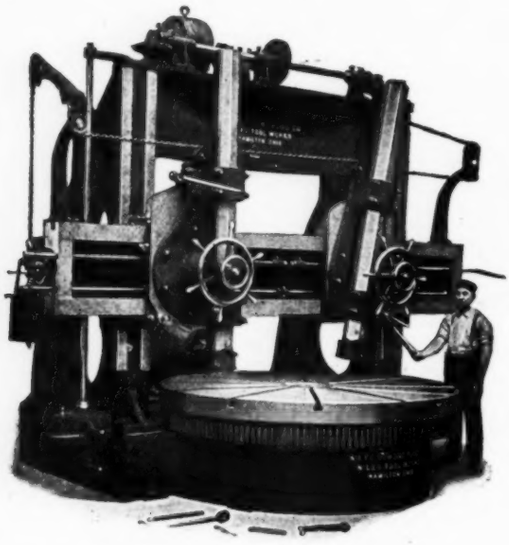


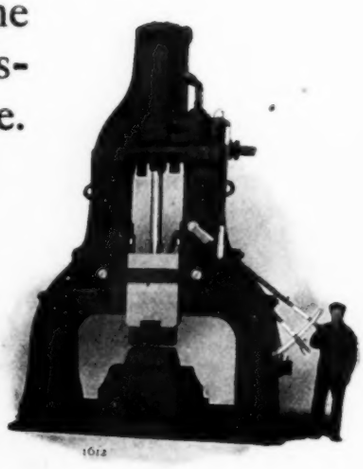
Hydraulic Railway and Boiler Shop Machinery.

All sizes of Lathes from the little Bench Lathe to the massive 125" Crank Shaft Lathe.



Slotting
Machines
6 to 68 inch
stroke.





Steam Hammers
250 to 40,000 lbs.
falling weight.

Boring Mills—25 sizes.
30 inch to 30 ft. swing.

Small Tools, see page 3.

Largest Builders of Machine

NILES-BEMENT-

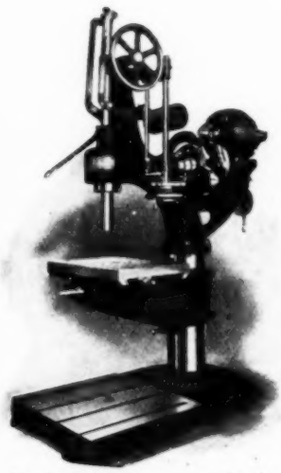
111 BROADWAY.

OFFICES:

Boston: Oliver Bldg. Chicago: Commercial National Bank Bldg. Pittsburg: Frick Bldg. St. Louis: 516 North 3d St. Philadelphia: 21st and Callowhill Sts. Birmingham, Ala: Brown-Marx Bldg. Agents: The Canadian Fairbanks Co., Ltd., Montreal, Toronto, Winnipeg and Vancouver. Agents for California, Nevada and Arizona: Harron, Rickard & McCone, 436 Market St., San Francisco, Cal., and 164-8 North Los Angeles St., Los Angeles, Cal. F. W. Horne, 70 C Yokohama, Japan.

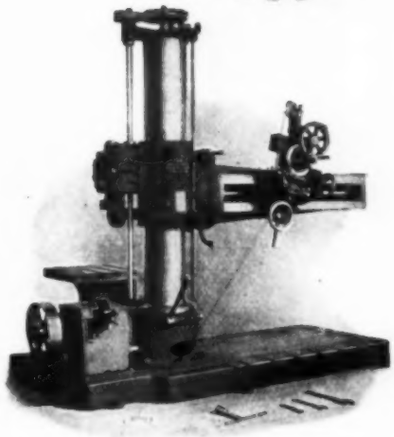
Every Description

To the Gigantic 14-foot Planer



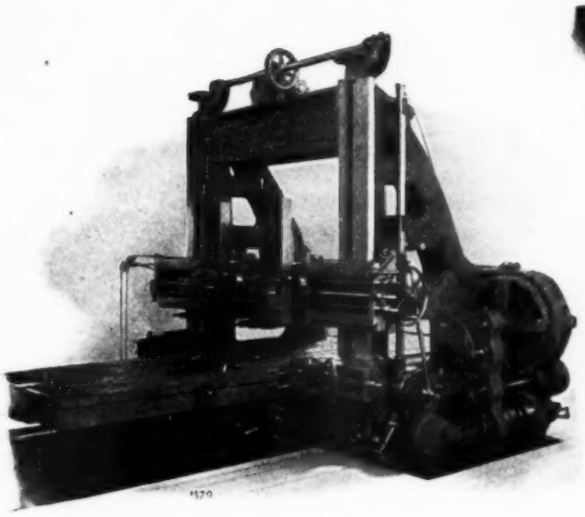
Vertical Drills up to 60 in.

We install complete machine tool and crane equipment for machine shops.



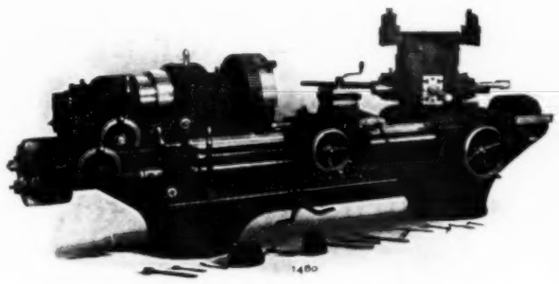
Radial Drills, 3½ to 10 foot arms.

Complete equipment for Railway and Boiler Shops and Ship Yards.

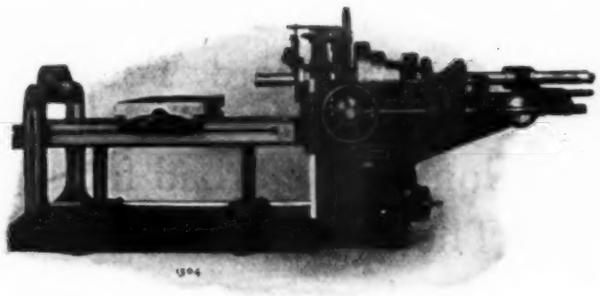


Planers, 17 in. to 14 ft. between housings.

Catalogues and full information on any tool sent on request.



Pond Rigid Turret Lathe. Two Sizes.



Horizontal Boring and Drilling Machines 46 in. to 80 in.

Tools in The World.

Precision Tools, see page 2.

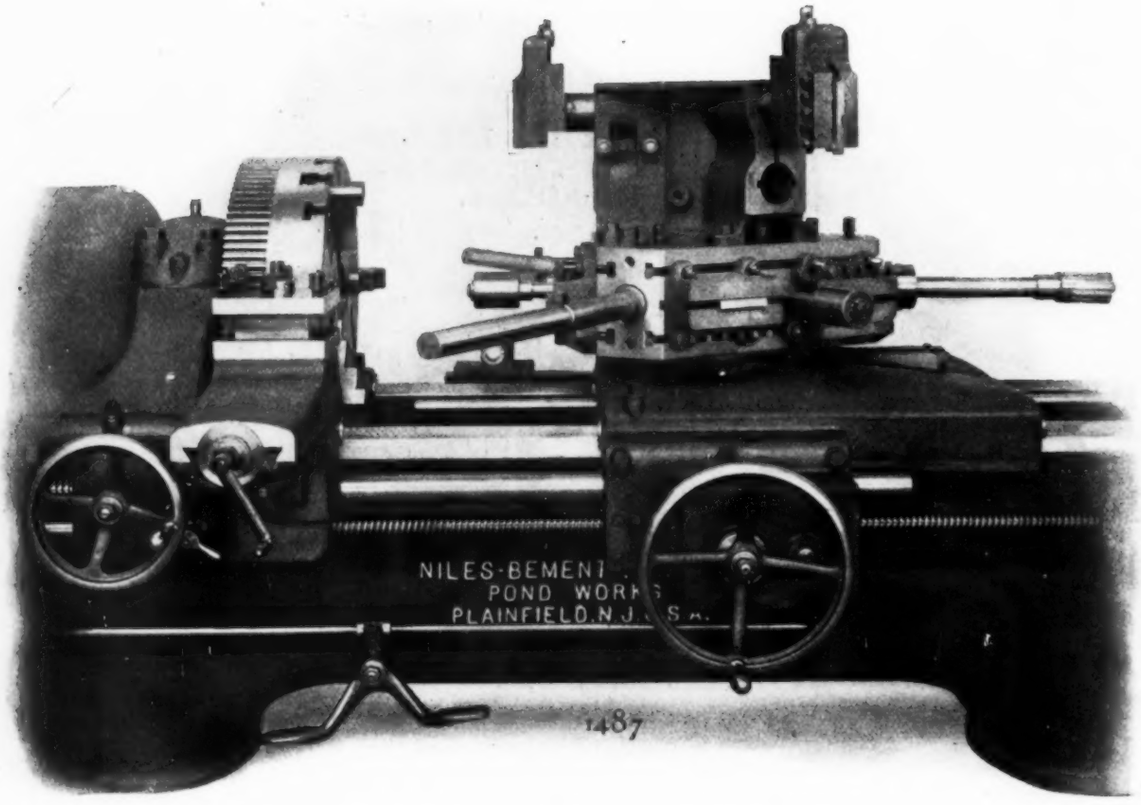
POND COMPANY,

NEW YORK, U. S. A.

OFFICES:

Boston: Oliver Bldg. Chicago: Commercial National Bank Bldg. Pittsburg: Frick Bldg. St. Louis: 516 North 3d St. Philadelphia: 21st and Callowhill Sts. Birmingham, Ala: Brown-Marx Bldg. Agents: The Canadian Fairbanks Co., Ltd., Montreal, Toronto, Winnipeg and Vancouver. Agents for California, Nevada and Arizona: Harron, Rickard & McCone, 496 Market St., San Francisco, Cal., and 164-8 North Los Angeles St., Los Angeles, Cal. F. W. Horne, 70 C Yokohama, Japan.

POND RIGID TURRET LATHE



TOOL EQUIPMENT OF POND RIGID TURRET LATHE.

Our Standard Tool Equipment may be used for a wide variety of work. The short stiff facing tools can be put in any position on the broad faces of the turret.

The tools in the extension turret will turn any diameter.

On chucking work such as gear blanks, pistons, etc., this machine will show savings of from 40 to 70%.

WRITE FOR CATALOGUE "THE POND RIGID TURRET LATHE"

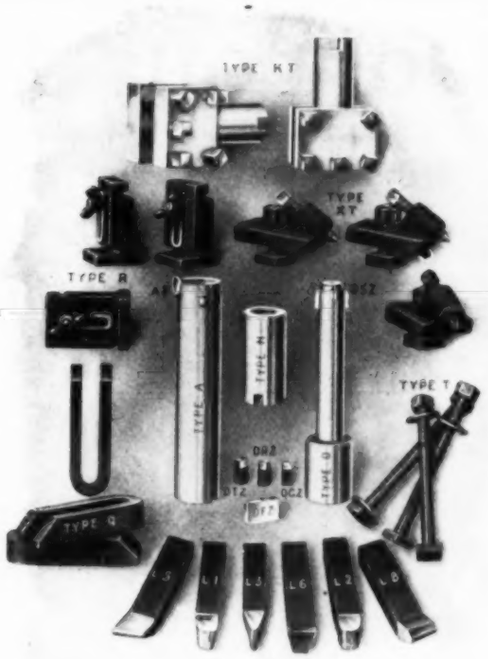
NILES-BEMENT-POND COMPANY

Trinity Building, 111 Broadway, New York, U. S. A.

OFFICES:

Boston: Oliver Bldg. Chicago: Commercial National Bank Bldg. Pittsburg: Frick Bldg. St. Louis: 516 North 3d St. Philadelphia: 21st and Callowhill Sts Birmingham, Ala: Brown-Marx Bldg. Agents: The Canadian Fairbanks Co., Ltd., Montreal, Toronto, Winnipeg and Vancouver. Agents for California, Nevada and Arizona: Harron, Rickard & McCone, 436 Market St, San Francisco, Cal., and 164-8 North Los Angeles St., Los Angeles, Cal. F. W. Horne 70 C Yokohama, Japan.

BULLARD



Boring Mill Tools

are the results of years of specialized experience in the development of modern Vertical Boring and Turning Mills. Their importance cannot be overestimated because

Both Quality and Quantity Of Work Depend On Tool Equipment

These Bullard outfits enable the Boring Mill to turn out the most accurate work it is capable of, at the fastest, most profitable rate. If your mill's productive capacity is not what it should be, look into the question of tool equipment.

Send for our new descriptive Catalog AE-14

The Bullard Machine Tool Co. BRIDGEPORT, CONN., U.S.A.

AGENTS: Marshall & Huschart Machinery Co., Chicago, Ill. The Motch & Merryweather Machinery Co., Cleveland, O. Chas. G. Smith Co., Pittsburg, Pa. C. H. Wood Co., Syracuse, N. Y. Pacific Tool & Supply Co., 556 Howard Street, San Francisco, Cal. Williams & Wilson, Montreal, P. Q. Chas. Churchill & Co., Ltd., London, E. C., England. Fenwick Freres & Co., Paris, France. Heinrich Dreyer, Berlin, Germany. Landre & Glunderman, Amsterdam, Holland.

Do Your Duplicate Work On A "Flat Turret"

It is the lathe of the present day, built to start work at once, easy to operate and not at all complicated. Get it in your shop at once and secure the big results that have made our lathe famous as a cost-reducer and output increaser on duplicate bar and chucking work. The finished pieces, in any quantity, are accurate, uniform and perfectly interchangeable.

See pages 12 and 13 for more details.

JONES & LAMSON MACHINE CO.,

Springfield, Vt., U. S. A., and 97 Queen Victoria St., London, E. C.

THOS. L. DICKINSON MAKER — N.Y.

DIAMOND TOOLS

Special shaped carbon, black diamond, pointed tools for turning Hard Rubber, Fibre, Brass, Bronze Composition, Celluloid, Paper, Cotton and Corn Husk rolls; for turning and drilling Battery Carbons or any material of a hard, tough, gritty nature. Hold their sharp cutting edges for months, they can be sharpened.

Thomas L. Dickinson, M'f'r, 47 Vesey St., NEW YORK.

C. W. Burton, Griffiths & Co., London, Sole Agents for Great Britain

KINKS If you haven't bought at least one of the ten Hill **KINKS** Kink Books in the past six weeks, you are just six weeks behind the great number of active, progressive ambitious men who have siezed this opportunity. The best little helpers a man can have, only 50 cts. apiece (2/6)—beautiful books—and full of meat. Don't delay. Send for Circulars now.

HILL PUBLISHING CO., 505 Pearl St., New York.

Black Diamond Files and Rasps

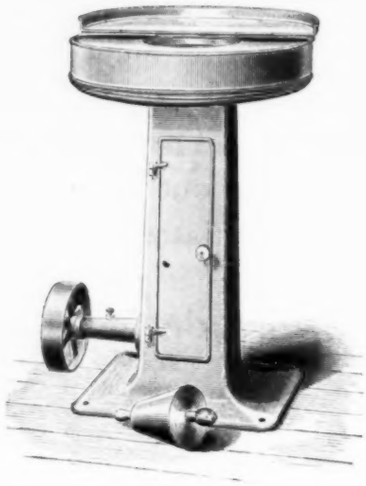
PERFECT ALWAYS

Twelve Medals Awarded at International Expositions

For Sale Everywhere

Copy of Catalog will be sent free to any interested file user on application

G. & H. BARNETT CO., Phila., Pa.



POWER LAPPING MACHINE

This machine is reliable, durable and thoroughly efficient. The lead lap, carried by the horizontal plate, can be charged with emery or other abrasive substance by means of the *lap roll*, which is furnished with the machine.

WRITE FOR CATALOG.

BUILDERS IRON FOUNDRY,

PROVIDENCE, R. I.

The Famous Creusot Works of France

Ten Views Show the Extent, Arrangement, Departments, Variety of Work and Equipment of This Foremost Metal-working Plant of France

BY J. B. VAN BRUSSEL

The famous Creusot Works of France, like most of our great industrial enterprises, had humble beginnings, and passed through varying phases and alternating periods of prosperity and difficulties, before becoming the large and perfectly organized metallurgical establishment which it is today. Actually, the Creusot Works occupy an area of about 3300 acres and extend uninterruptedly for a distance of three miles. The different services are connected by a system of railways 200 miles in length, with a rolling stock of 55 locomotives and 1600 cars. The following figures give some idea of the importance and varied character of Messrs. Schneider & Company's Works.

Production in 1907:

Iron and steel plates	150,000 tons
Armor plates	6,000 tons
Ship construction, bridges and iron works	12,000 tons

The number of employees of all classes varies from 15,500 to 16,000.

The works comprise several large sections: The mineral section, the metallurgical section, the construction department, and the executive department.

The mineral section can be passed by saying that coal is raised from several pits, varying in depth from 1100 to 1400 feet.

Passing to the manufacturing departments they can be roughly divided into three subdivisions: The first comprises the blast furnace and steel plant, the second the rolling mills, steam hammers, etc., and the third the electrical works, the gun-making shops and the firing grounds.

The Blast-furnace Department and Steel Plant

The blast-furnace department includes five furnaces in blast; of these three are for the Bessemer-Thomas process, and two produce forge pig or pig for ordinary work according to requirements.

The steel department comprises four independent groups of workshops: (1) For the manufacture of steel in ingots and for special castings; (2) For the forging of heavy pieces with a full plant for cementation, tempering and reheating; (3) Machine shops for finishing all classes of steel work; (4) The wheel-tire shops.

For the largest ingots, the weight of which may exceed 120 tons, a special casting pit has been provided. At one end of this pit a large liquid steel hydraulic press of 10,000 tons capacity is installed. See Fig. 2. Annexes to the first group of the steel works include a foundry where machine parts and other complicated castings are produced, as well as castings for gun mountings, stern frames, and other pieces required for ship construction. The tempering-shop, which is placed near the main forge, contains special furnaces for heating armor plates, gun parts, etc.

The 100-ton steam hammer of Creusot was the largest of its kind when it was erected. Its maximum power can be raised to 120 tons, and the complete installation with four furnaces and four cranes forms a very remarkable plant. See Fig. 1.

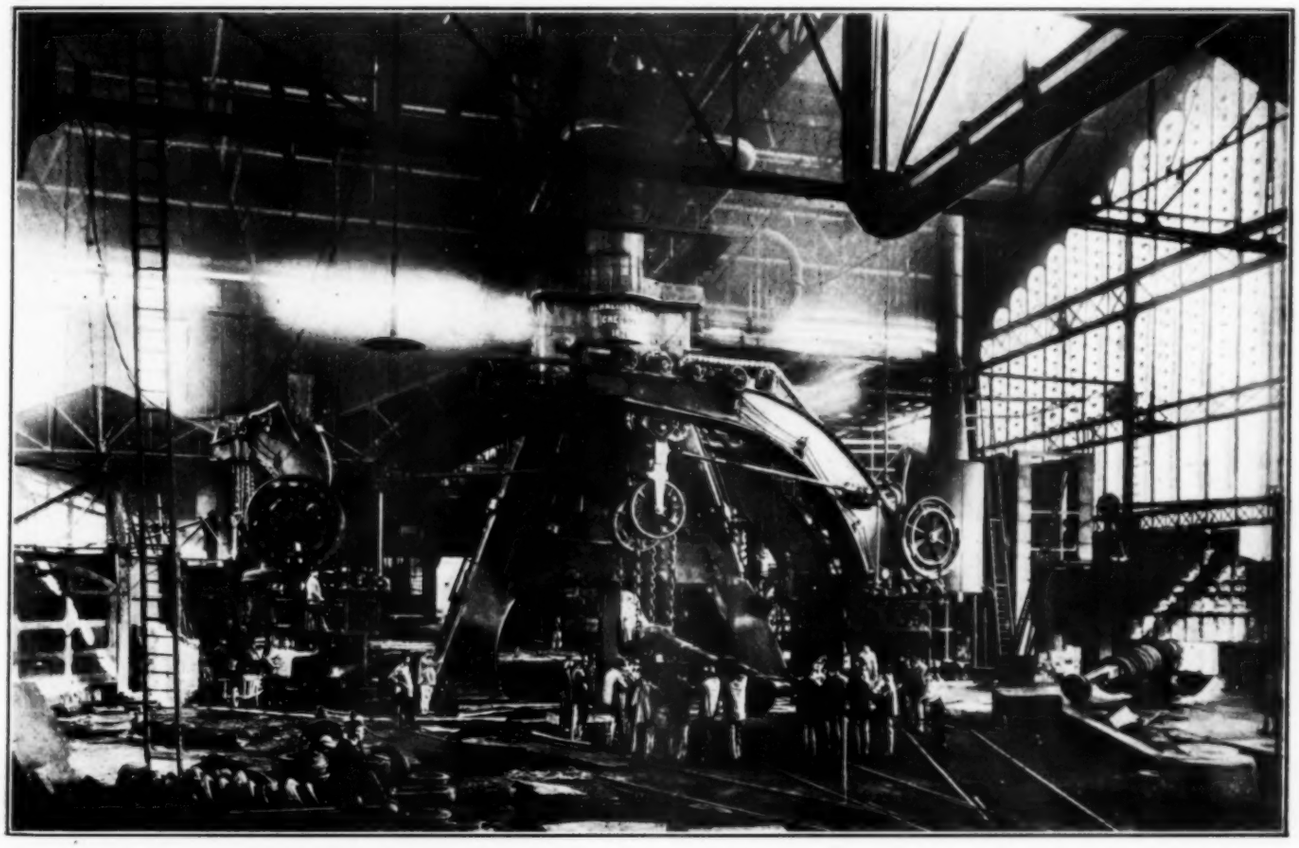


FIG. 1. THE 100-TON STEAM DRIVEN HAMMER AT CREUSOT

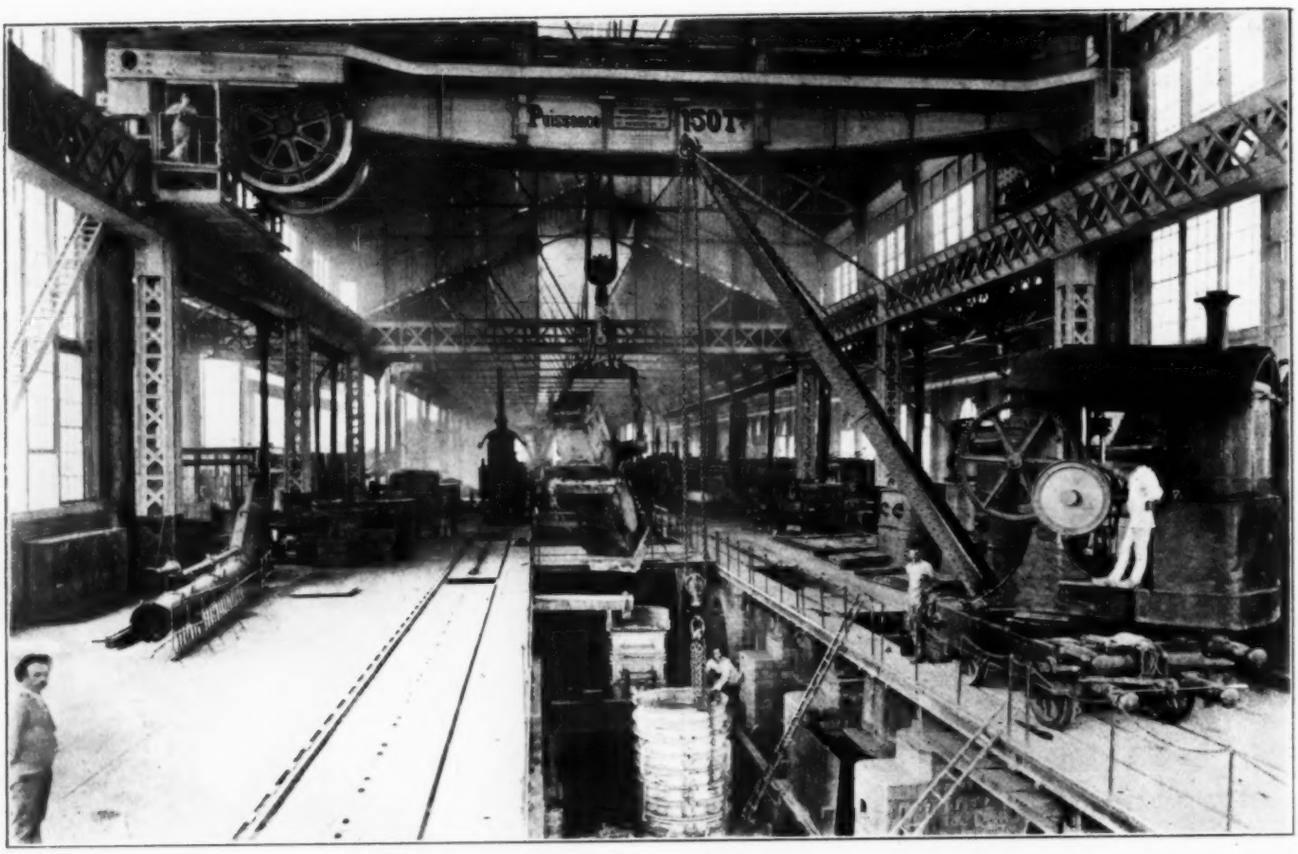


FIG. 2. THE INGOT CASTING PIT

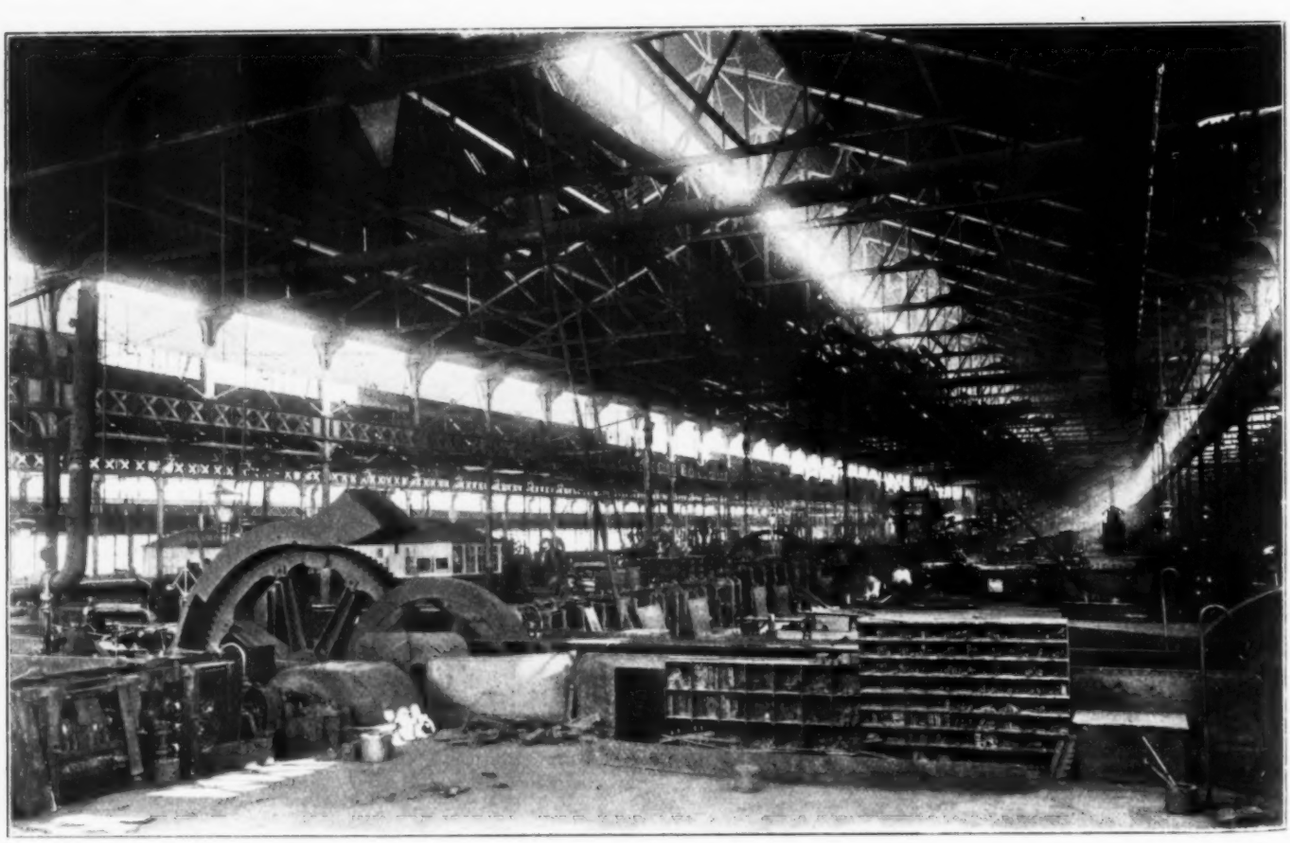


FIG. 3. THE MAIN BAY OF THE ROLLING MILL

The fitting-shops are important and extensive; a multitude of operations are performed here, the most important being for armor-plate work, gun-making, etc.

The fourth group of the steel works contains shops for making tires. They are connected to the ingot foundry by a tunnel 400 yards in length, in which rails are laid to allow the rapid transit of the ingots intended for making tires. The Creusot rolling-mill department covers a space of over 40 acres, of which 25 acres are occupied by buildings. Thirty-five hundred workmen are working here; motive power is generated by 150 steam engines having a total capacity of 12,000 horse-power.

works and are distributed among the various mills for direct rolling.

All the mills for finished products, bars, sheets, and plates are placed under the large bay of the main building and occupy the whole length. This length, 1400 feet, was found insufficient some years since and a second parallel line of mills has been put up for sheet rolling. All of the mills are fitted with three-high rolls. Fig. 3 shows the main bay of the rolling mill, Fig. 4 shows the large steel foundry.

The Iron Foundries

The construction department comprises three iron foundries, of which each has its own equipment. For the 100-ton steam

ing of steel ingots, the weight of which does not exceed 10 tons.

The Fitting and Erecting Shops

The fitting and erecting shops are the largest in this department. They contain more than 500 machine tools of all kinds. Owing to their importance, these shops have been divided into two main sections; one for locomotives, small stationary engines, and torpedo-boat engines; the other for large marine and stationary engines. The section which deals more especially with locomotive work comprises eight buildings, three of which contain lathes, four other machine tools, and one for erecting. See Fig. 5. The sec-

FIG. 4. THE STEEL FOUNDRY

The plant has been arranged to obtain systematic and continuous working, and to prevent the carrying backward and forward of the material under treatment. For instance, as regards the manufacture of iron, form the point of arrival of the pig until the rolled material reaches the delivery wharf, a straight line is followed through the puddling furnaces, the shingling hammer, the roughing rolls, the shears, the piling, the reheating furnaces, the finishing rolls, the inspection platform, and the delivery on the railway trucks. Since 1860 steel has gradually superseded iron, and at the present time nearly three-fourths of the products manufactured at the rolling mills are of steel. The ingots, as a rule, are received hot from the steel

hammer certain castings weigh over 100 tons and special means have to be resorted to for casting such heavy pieces. For doing this two cupolas have been erected on a level above the floor level of the foundry; these two cupolas can each melt 10 tons per hour. As the charges are melted they are poured into two reservoirs each holding 50 tons. The bottoms of these reservoirs are also above the level of the foundry floor. When everything is ready for casting the iron is allowed to flow by gravity to the mold. The cranes are required only for carrying ladles containing a small quantity of cast iron for feeding.

The smith's shop is fitted up with furnaces and steam-hammers for the work-

tion more especially set apart for the construction of large stationary and marine engines comprises 10 buildings; they are divided into turning shops, drilling, boring and general machine shops and one for erecting. A view in one of these shops is shown in Fig. 6. In these shops are all of the machine tools for machining exceptionally large work. Among others are a squaring-up lathe that can turn up to 33 feet in diameter, lathes and boring machines which can take shafts 82 feet long, a boring machine to finish boring cylinders 10 feet in diameter by 17 feet high, a machine for the cutting of double-helical teeth on wheels 10 feet in diameter; a planing machine that can work pieces 11 feet 6 inches wide by 32

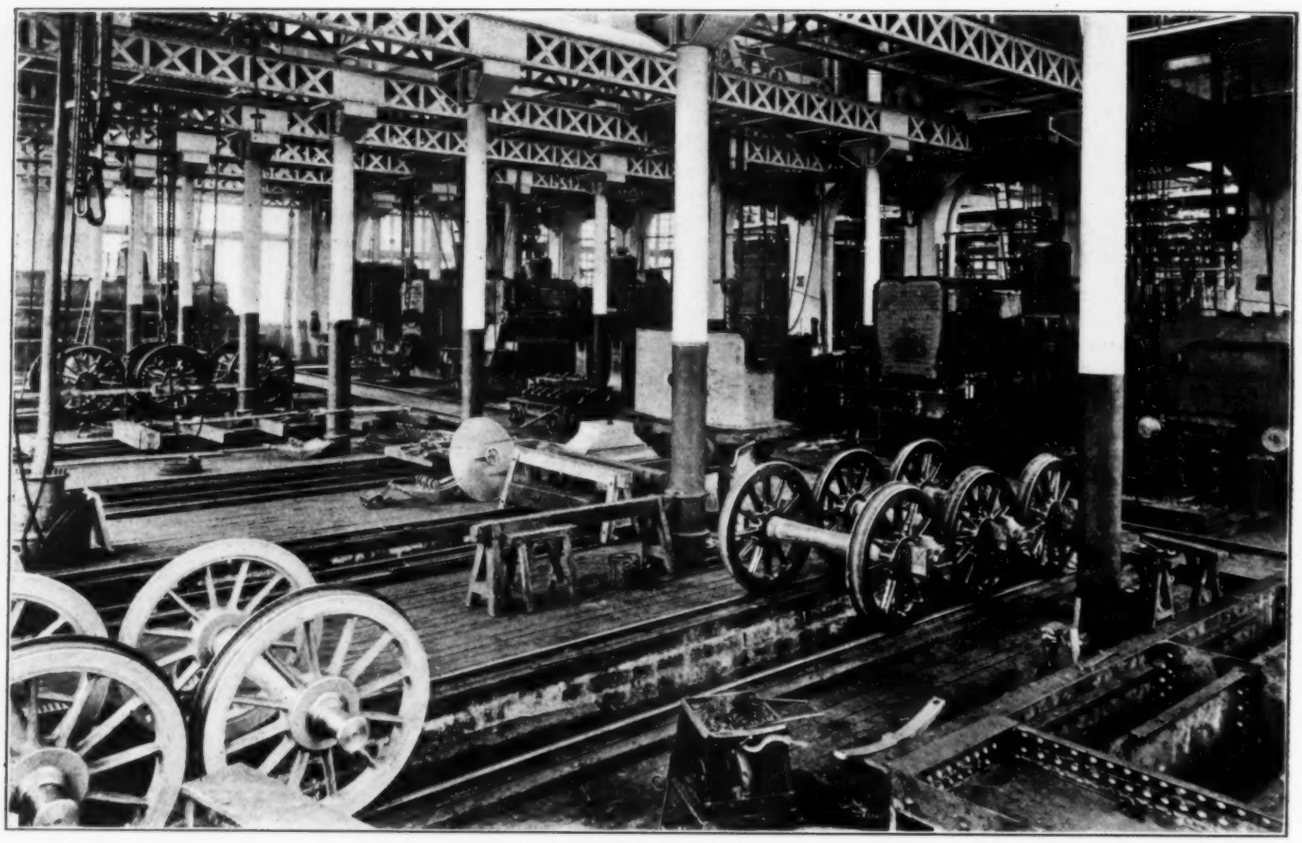


FIG. 5. THE LOCOMOTIVE ERECTING SHOP

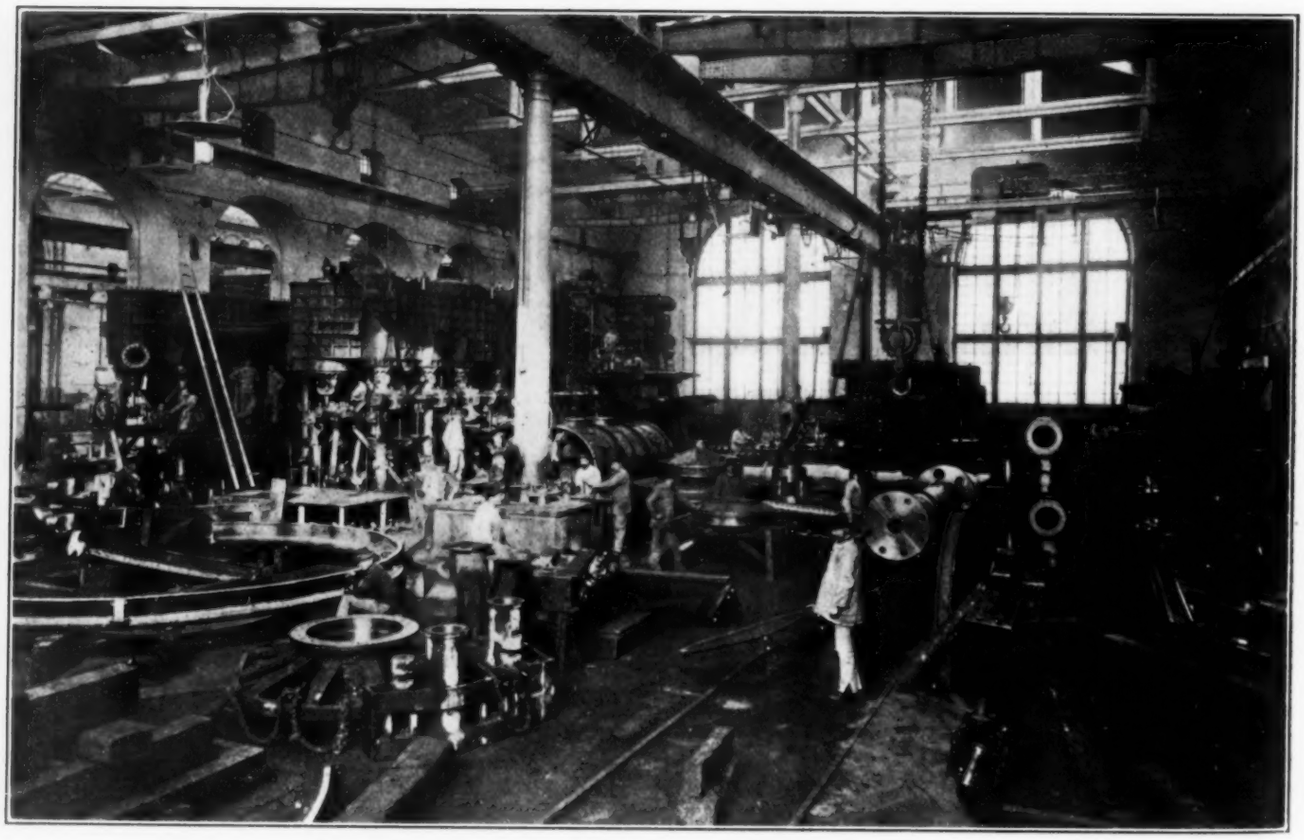


FIG. 6. ERECTING SHOP FOR LARGE MARINE ENGINES

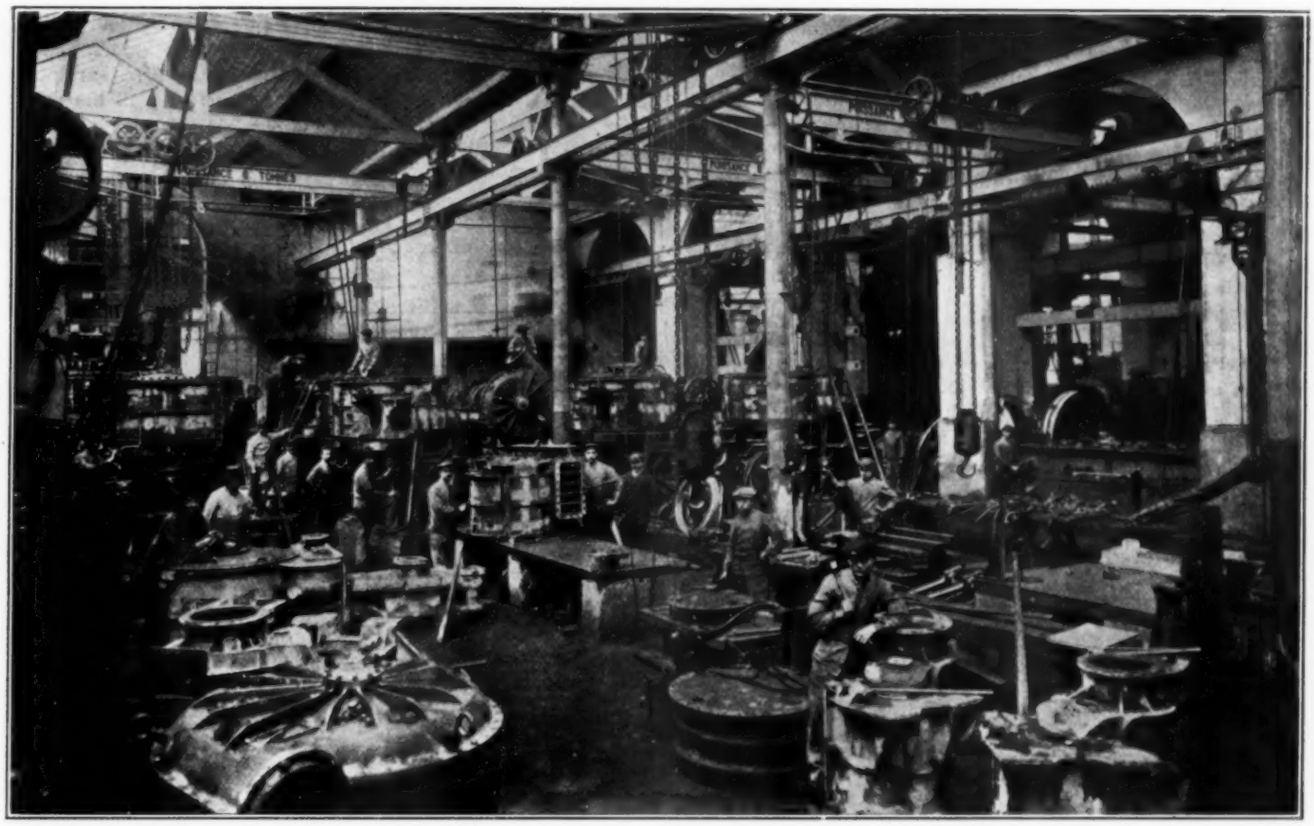


FIG. 7. ERECTING SHOP FOR TORPEDO-BOAT ENGINES

feet 10 inches long, etc. The torpedo-boat engine shop is shown in Fig. 7.

The manufacture of the various tools which are necessary for the machine shops is centralized in one special building, fitted up with the necessary appliances for this work.

The electric-construction department consists of two main shops situated at the south end of the works. One of these serves for the fitting of all mechanical parts of small and medium-sized electric

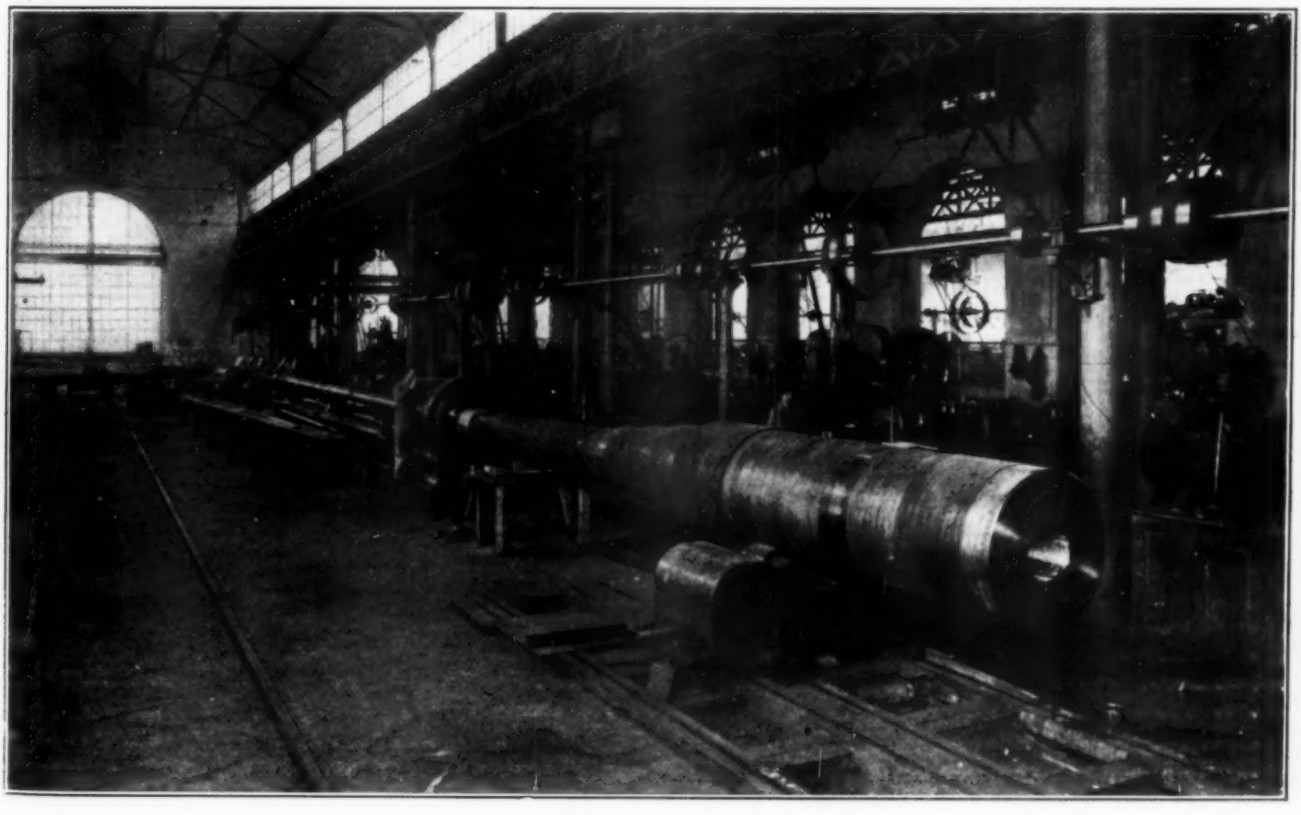


FIG. 8. ONE END OF THE ORDNANCE SHOP

machines and for the erection of large dynamos. One of the bays of this shop is specially set apart for stamping, cutting out and putting together dynamo sheets. It contains punches, lathes and hydraulic presses the largest of which are adapted for finishing drum armatures up to 10 feet in diameter. The erection of small and medium-sized dynamos, fitting of accessory devices and winding are carried out in the other main building.

The Ordnance

The artillery or ordnance shops cover an area of over 35,000 square yards, and are divided in two groups (north and south) of three spans each. The north group machines large- and medium-sized guns, coast-defense gun carriages, gun mountings, ships' turrets and turrets for land service. The south group is used for the construction of field and siege artillery.

Among the largest machine tools may be mentioned two gun-boring machines of 50-foot travel and 48-inch hight of centers; a lathe 56 inches hight of centers and 50 feet between centers and one lathe that can turn up to a diameter of 46 feet. These tools are employed for machining guns of the largest calibers. Among the larger plate-working machines, there is one 150-ton hydraulic press for stamping gun-carriage cheeks, a hydraulic riveting machine, and two special hydraulic presses for putting on the bands of projectiles. The plant is completely equipped with full sets of all the necessary gages, standards, instruments of precision, etc., required in the manufacture of ordnance.

Fig. 8 shows a view in one of the ordnance shops, and Fig. 9 shows the shop devoted to the manufacture of turret armor.

The Works at Havre

Schneider & Co. also have an artillery works at Havre. These shops cover an area of over 120,000 square feet, and consist chiefly of seven connected buildings, each 425 feet in length. The spans vary from 30 to 60 feet in width. The larger shops are provided with steam traveling cranes, arranged to work in combination so as to handle loads weighing 100 tons. See Fig. 10.

The two spans located on each side of the large shop referred to are used for machining guns of medium and small calibers. They contain the less powerful lathes as well as large drilling, mortising, shaping, boring and planing machines. In a further span is placed the smaller machinery. The fifth span is used as the fitting shop; here the various breech-mechanisms are finished, as well as the torpedo-launching tubes with their gear and accessories.

The machine tools are very numerous, and are divided among the various shops in such a way as to reduce as far as possible the operation of lifting and transporting the various parts of gun and carriage work. High-speed precision tools are provided for completing all the minute and numerous operations required in the manufacture of ordnance and ammunition. Among the most powerful tools may be mentioned eight lathes for machining tubes 46 feet in length and up to 100 tons in weight.

There are also three proving grounds of which two serve especially for inspection tests of guns and mountings. The third is used for ballastic tests, long-range firing, determining firing practice tables, for testing fuses, etc.

The shipbuilding and bridge-construction yard is situated at a distance of 25 miles from Creusot, though it forms a part of the works.

Since 1906, Messrs. Schneider & Co. have extended their electrical department, and constructed a works at Champagne on the Seine. These works include seven large shops, of which the main one has a total length of about 580 feet and a width of over 170 feet.

FIG. 9. ARMOR PLATE SHOP

Recent figures compiled by the Bureau of Statistics show a very large growth and wide distribution in the exportation of American made typewriting machines. As against a total exportation of less than $1,500,000 worth of the American product during the year 1897 the records show a total export value of $6,250,000 in 1907.

Some Vicissitudes of the Job Shop

By J. G. Dornbirer

Did you ever see a manufacturing establishment located on a site which you thought ought to be occupied by a good stiff vacuum? Well! here was one. About 15 years ago a young man inherited $200,000. He was a bookkeeper in the employ of a wood-pulp manufacturing concern. This firm was financially in such a condition that they thought best to let the bookkeeper have all the items which enter into a profit and loss account excepting one, in the hopes that it might leak out that the "shebang" was manufacturing something besides deficits. This item was the wood from which pulp is made. Its absence certainly made profits look large.

The office was located about one square from the mill so the bookkeeper never got over to see the process. But he often heard discussions as to the per cent. of water contained in wood pulp when ready for shipment, which runs from about 40 to 60 per cent. or more, the remainder might have been dried apples for all he knew. He had an idea that an abundance of power might come in handy, so he made a note of it. He decided that manufacturing wood-pulp was the thing. He located in a *ravine* where there was a water fall of about 8000 cubic feet of water per minute the year round.

There was plenty of natural gas, so this valuable waterpower was not considered worth a dam. The bookkeeper bought it cheap. The nearest railroad was about 10 miles up stream. There was quite a current in the stream so this bookkeeper argued that it would cost nothing for motive power to transport his supplies or his product one way. He did not know that there was such a thing as electricity; at least we presumed so since he never mentioned the feasibility of generating the current at the falls and transmitting it to a point which we might call *terra firma*, for short.

He took his money with a bad case of mental aberration and began building down in the ravine. He induced some of his friends to mix their assets with his. They built a 30-ton scow and put in an old 20 horse-power portable engine to propel it up stream. So enthusiastic was this man over his method of transportation that he saw a variety of possibilities. In speaking to me about it he said that he thought very seriously of setting a planer in the scow and connecting it up with the paddle wheel, then of buying his lumber for the mill in the rough and plane it up while the scow was floating from the town down to the proposed factory site. This would also keep the men busy for at least one way. I believe he was one of the perpetrators of the first cost system.

In the mean time the machinery began to arrive. The only way to get the freight from the scow to the mill (which was about 100 feet) was to carry it with as many men as was necessary. It never entered his erstwhile fertile mind to build a little tramway and a car. The result was that by the time the mill was completed all of the men in his employ listed heavily to starboard.

When the grinders were to be set up it was discovered that the flanges were too small to screw on the stone shafts. The shafts were about six inches in diameter and were threaded with right-and-left acme threads, three pitch. The flanges were 36 inches in diameter and weighed about 600 pounds each. There were six of these flanges and they realized what a job it would be to send them to the machine shop. So they sent for the boss to come down to see what could be done.

On the way down in the scow the boss noticed that the man in charge always piloted the craft where there was the least current, and then amused himself by spitting in the water to see if they were moving. Frequently a gust of wind would blow the tobacco juice clean up in the front end of the scow, considerably to the annoyance of the other passengers who frequently requested him to expectorate a little more southwest by west. "Molly-coddle" and "strenuous" were very obscure words in those days so he had to put up with being called down in prevailing terms.

When the boss arrived he went to the mill and was shown the flanges. They were

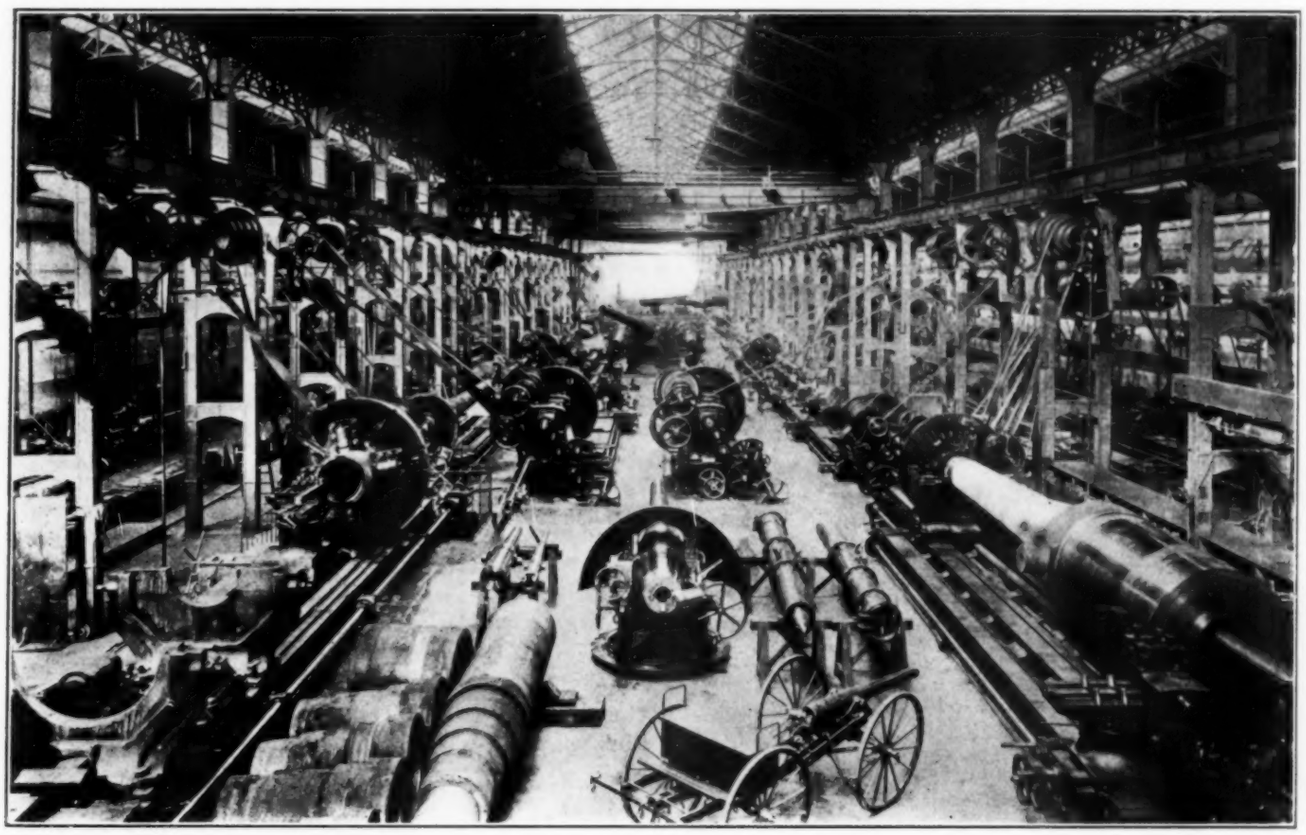


FIG. 10. ORDNANCE SHOP AT HAVRE

about five inches thick in the center and tapered down to about one and one half inches on the rim. I was sent back to the shop to have a sleeve made of the following description. The sleeve was to be 12 inches long, to be a nice working fit in the hole, to have a one-half inch hole about four inches from one end and a thirteen-sixteenth hole one inch from the other end. Now in the one-half inch hole a piece of steel was driven of the proper form of the acme thread. A hole was to be bored immediately in front and back of cutter about seven-eighths in diameter.

The flanges were laid on a pair of horses one at a time. When I arrived the next day with this apparatus the boss shoved the shoe into the hole in the flange put a bar through the thirteen-sixteenth hole, and proceeded to screw this single toothed tap through the flanges. Then the tooth was turned half way around and we had the left-hand tap for the three other flanges.

By this time it was noon, so we were invited to dine with the factory foreman. It did not take us long to see that food had not come into general use.

We hung around the mill until scow time and noticed that the millwrights did not pour sulphur between the stones and their flanges as the blueprints of the manufacturer specified. When the mill was started a whole grinder went to pieces. The bookkeeper wrote to the concern that the work was very defective and the cost of the delay would be charged back. The manufacturer sent a new machine by express a distance of over seven hundred miles. But there is no use jeopardizing one's soul to apply the proper name to this novice.

A Heavy Locomotive Wheel Lathe

The Latest Development of an Interesting Turning Problem in Which the Output of the Lathe Is Limited by the Steel Used in the Tools

EDITORIAL CORRESPONDENCE

Turning locomotive tires is a constant source of expense to any railroad and much time and energy have been spent to devise and build new tools which would reduce this cost.

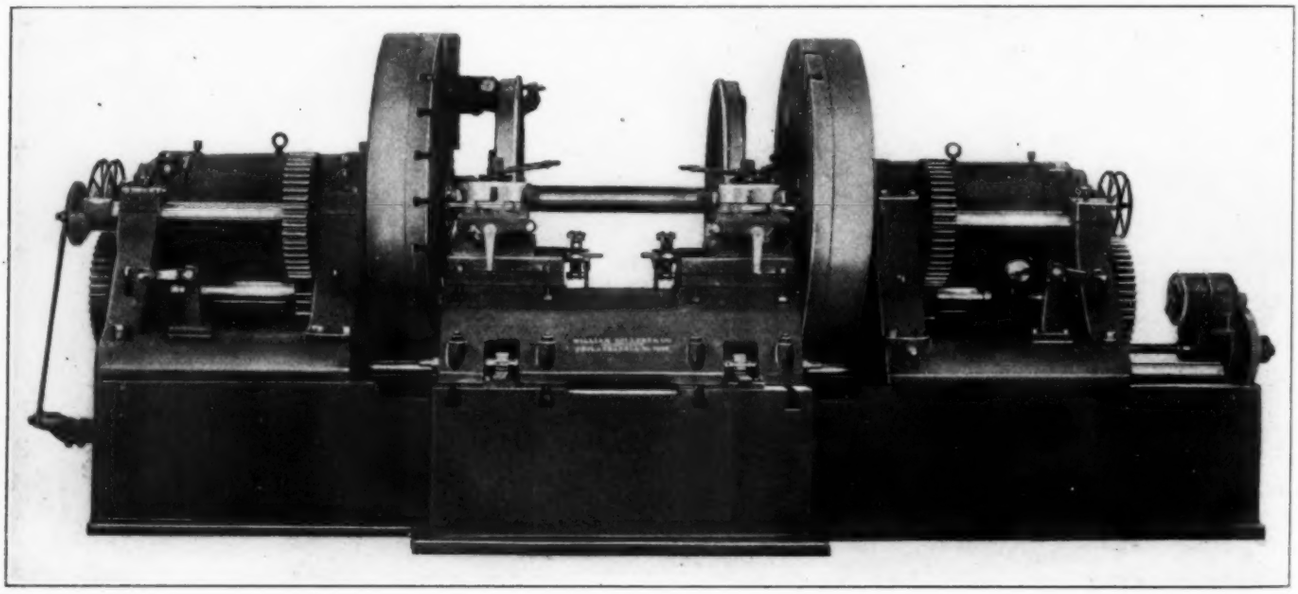


FIG. 1. A 90-INCH DRIVING WHEEL LATHE

The latest driving-wheel lathe has recently been built by William Sellers & Company, Philadelphia, Penn., and is shown as a whole in Fig. 1, with a pair of wheels in place. It will handle a pair of 90-inch driving wheels, which is larger than any in use in this country today and ought to be sufficient for some time to come.

The lathe may be said to consist of the bed, the fixed head at the left, the movable head at the right and the tool bench in the center. Each head carries a very heavy face plate with a pocket to receive the end of long crank-pins. Each face plate is driven by a pinion on the end of the short shaft shown at about the center of each head, the driving gears being of large dimensions and close to their bearings in each case.

A 50-horse-power motor is behind the left-hand head and transmits power to the other head through the large shaft shown in both Figs. 1 and 2. The motor at the extreme right of Fig. 1, is simply for moving the right-hand head either up to work or away from it to take out the finished wheels and put in another pair. This motor drives the screw through a friction clutch which is set to slip before the center rams the axle hard enough to do any damage. Two hand-wheels at each end are for adjusting the inside or center carrying spindle into the work to suit the varying distances which axles project from the wheels. The inner wheel is simply a lock nut. This movement is of course inside and independent of the main spindle which carries the face plates and the work.

Railroads differ as to which crank-pin leads, some having the right and others the left so to avoid two pockets in the face plate, provision is made for changing the relation of the face plates by turning the right-hand plate through a half circle. All that is necessary to do this is to draw out the lower right-hand pinion by means of the crank shown in Fig. 1, when the left face plate can be revolved half a turn while the right remains stationary and the pinion again thrown into mesh.

It will be seen that the tool bench has no guides but depends on the pinions and rack carrying it in a true path. First one rack was bolted and doweled fast, the tool bench squared with the lathe centers, then the other rack was similarly fastened and it was found that the error in traversing the tool bench from maximum to minimum diameters was so small as to be entirely negligible, which shows very accurate gear and rack cutting.

On each end of the tool bench is a tool slide, saddle and carriage, each carriage carrying a turret for tools. These saddles are fed in unison from a single feed shaft which runs through the bed and is driven by the slotted disk at the left of the pinion shaft of the stationary head. The tools are fed into the work by the cranks on the cross-feed screws, micrometer stops being provided as shown in Fig. 6. The turrets are turned by the ratchet lever shown which also locks them after being indexed by the locking lever at the bottom. The locking is accomplished by a very neat device which will be shown later.

Fig. 2 gives a better idea of the driving clamps and the construction of the center carrying spindle.. These clamps are adjustable on the slides for different diameter wheels, the graduations showing the proper place for different wheel centers. The lower clamp at the right is in locking position while the upper one is thrown down to allow a wheel to be put over it. The spring latch on the back holds them in this position so that wheels may be put in place more easily. Figs. 3 and 4 show this in detail. The inside jaw of these clamps has teeth to bite the tire, while the cone-pointed setscrew simply forces the tire against it. Should there be any tendency to slip the whole clamp moves sidewise as seen at the left of Fig. 2, acting as a toggle and forces the teeth deeper into the metal.

The projecting portion of the center spindle is held in place by the flanged support bolted to the face plate and carrying the gland or bushing which is slightly tapered and drawn into place by the bolts shown. This enables the center to carry any strains due to unequal driving. Both centers, of course, revolve with the work.

The coring of the face plate looks rather peculiar, but is done to allow the slides carrying the driving clamps to be moved into the positions necessary to get between the spokes of wheels having odd or even numbers, and whether the crank-pin is on a spoke or between two of them as there is no uniformity in this respect. The face plate is graduated so that these clamps can be adjusted to the right position. This only makes it necessary for the wheel turner to count the spokes in the wheels and note the crank-pin position, after which he can set up the lathe in short order without any preliminary trials which are unpleasant and costly when you count the time the crane is occupied and all of the men it affects.

The locking of the sliding head is a little out of the ordinary and is interesting. Fig. 1 shows the three binding bolts and between the two a horizontal bolt head. This controls a wedge which reaches through the head and can be seen at the left of Fig. 2. It does all the locking of the head on that side and does it quickly and rigidly, as the wedge goes through a very heavy eye or yoke connected to a strap or shoe which draws the head firmly to the bed on that side. This does away with going to the other side to lock the head and saves time.

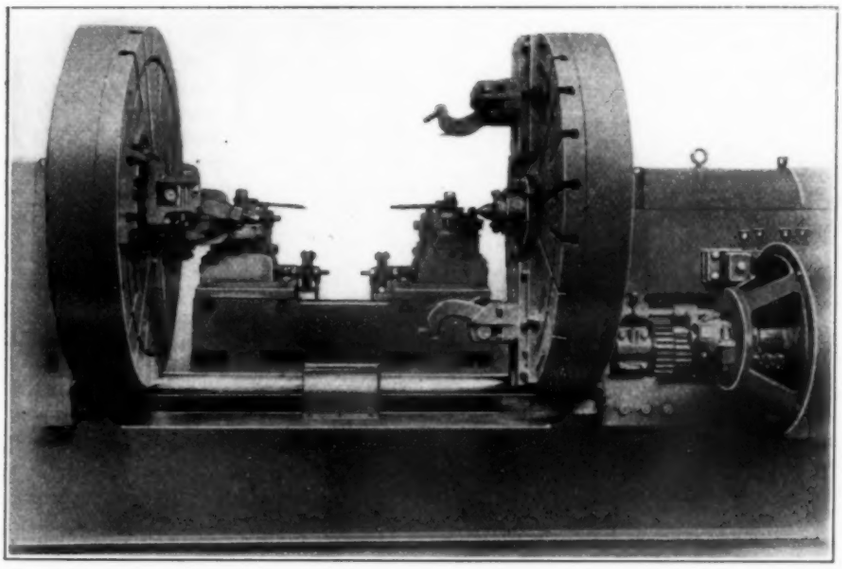


FIG. 2. A CLOSER VIEW OF FACE PLATES, DRIVING CLAMPS AND THE MAIN MOTOR

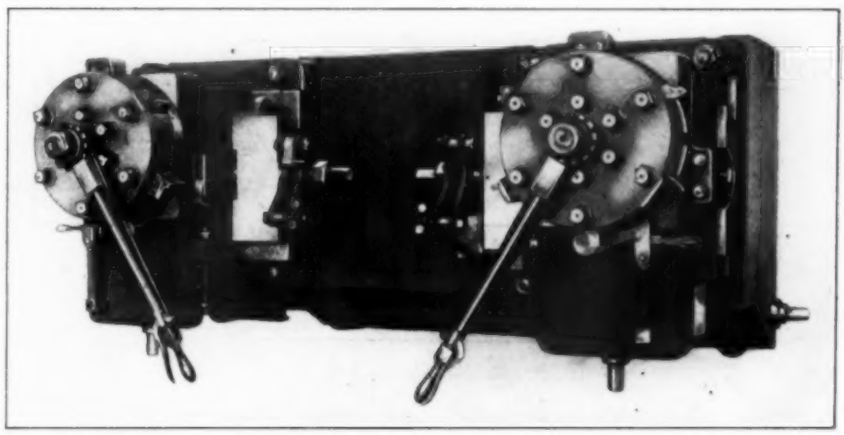


FIG. 5. TOP VIEW OF THE TOOL BENCH

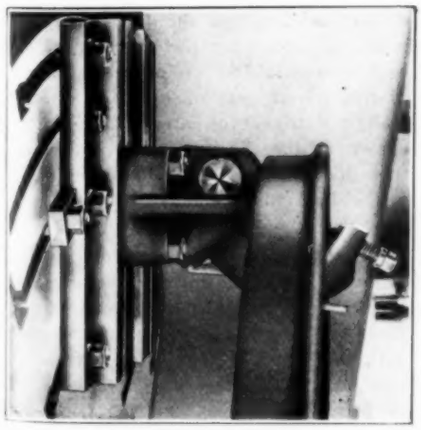


FIG. 3. UNLOCKED

FIG. 4. LOCKED IN PLACE

The turret is particularly interesting, and is shown in detail in Fig. 6. The center post has an opening through it for the long roughing tool so that the turret holds five tools. The lock is shown in the top view and the section below it. The turret is turned by the long lever on top, with its latch catching in the slotted ring *A*, which is keyed to the center post, the whole thing turning together. When the turret is locked in position the latch is drawn out of the slot leaving the lever hub *B* free to turn on the post. The lower end of this hub forms an edge cam and bears against *C*, so that moving the lever in the right direction forces the cone ring *C* down into the turret and binds it during the cut.

Hardened surfaces are used liberally in the construction, the bushings for set-screws, the rings under the outer ends of the tools and between *A* and *B* being examples of this. In addition, the face of the turret over the roughing tool has a hardened steel plate to take the cutting action of the chips as they cut out the steel casting from which the turret body was made.

Two of these lathes have been built,

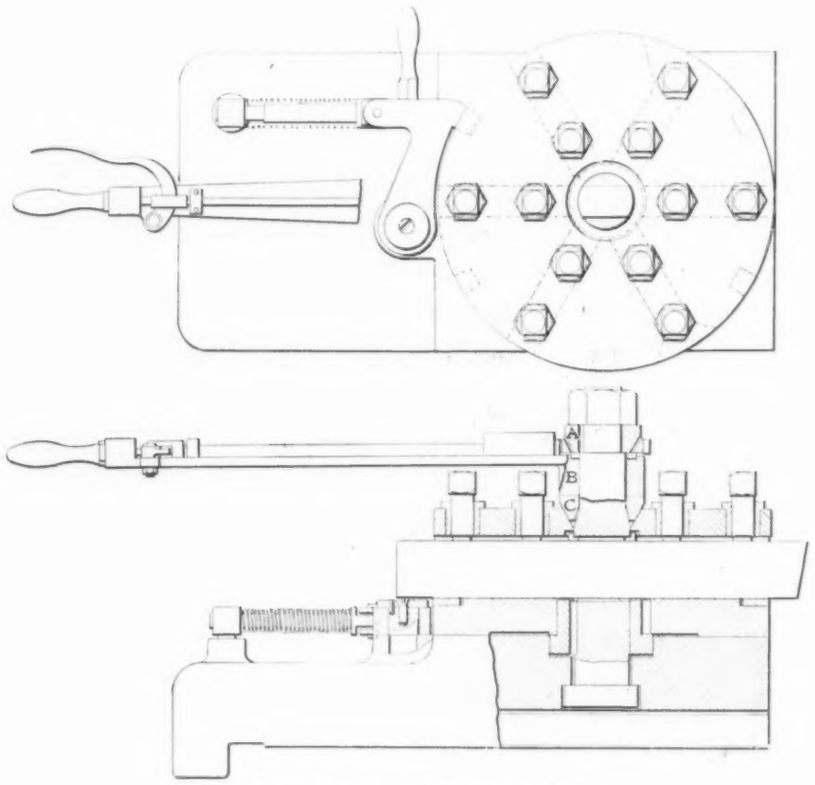


FIG. 6. DETAILS OF THE TOOL TURRET

one 80- and the other 90-inch swing, both being 10 feet 6 inches between face plates. The beds are 3 feet deep, the heads 6 feet 6 inches wide by 5 feet long and the face plates 15 inches thick. The effective swing of the large lathe is from 48 to 87 inches diameter and the other from 48 to 78 inches, both on the tread of the wheel.

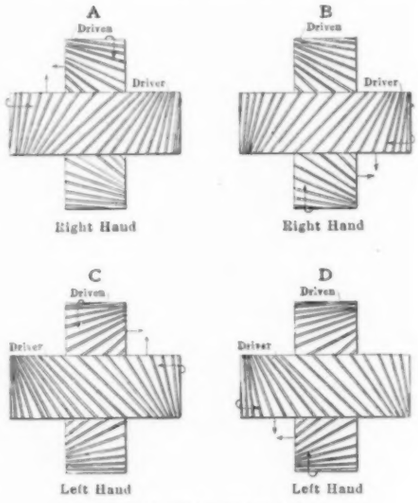
Direction of Rotation and Thrust of Helical or Spiral Gears

By Wm. F. Zimmerman*

In machine designing where motion is to be transmitted between two non-parallel and non-intersecting shafts, helical or spiral gears are often employed. The use of helical gears generally causes some study on the part of the designer to determine the proper direction of the teeth, having given the direction of rotation of the two shafts which are to be connected. Another point about helical gears which also causes some study after the direction of the teeth has been determined is the direction of the lateral strains, that is, the direction in which the helical gears tend to move along their axes when transmitting motion. The proper direction of strains is very important to correctly locate the ball-thrust bearings or other suitable anti-friction devices.

It sometimes occurs that a newly designed machine when started for the first time has a shaft which is driven by helical gears running in the opposite direction to that which was intended, or that the anti-friction washers have been located on the wrong side of the helical gear. To obviate the above and reduce the chance for mistakes in directions of rotation and strains in helical gears, I have arranged four diagrams of helical gears, as shown in the illustration.

The diagrams are arranged to readily illustrate every possible combination with helical gears, giving the direction of the teeth, their rotation, and the direction of the lateral strains when they are transmitting motion in the directions indicated. They can be readily used by the draftsman



SPIRAL GEAR DIAGRAMS

and held in the proper position so that the rotations are identical with those for which the directions of the teeth are sought. These diagrams eliminate the necessity of consulting a gear model, nor is it necessary to go through a series of hand manipulations describing the rotations in the air.

In the diagrams, *A* and *B* represent a pair of right-hand helical gears with the direction of rotation of the drivers reversed.

The diagrams *C* and *D* each show a pair of left-hand helical gears, also with the directions of their drivers reversed. It should be noted that reversing the direction of rotation of the drivers reverses the directions of their lateral strains. Also if the driven gears are made the drivers and rotating in the same direction, as shown, the lateral strains are also reversed; that is, if in the diagram *A* the driven gear is made the driver and rotates as indicated, the gear marked the driver, which is now the driven gear, will rotate as shown, but the lateral strains of each gear would be as in the diagram *B*. If the driven gear of the diagram *B* is made the driver, the lateral strains are as shown in the diagram *A*. This is also true of the left-hand combinations shown in the diagrams *C* and *D*.

*Chief draftsman, Gould & Eberhardt.

The total value of importations of bicycles into Belgium during the year 1907 increased by more than $44,000 over the year 1905, and $32,800 when compared with the year of 1906. The increase for bicycle parts amounted to $172,600, when compared with 1905 and $234,000 over 1906.

Pneumatic Fixtures for Holding Work

The Application of Compressed Air for Holding Various Kinds of Work To Be Machined and Its Effect on the Cost of Production

BY M. E. SERVICE*

The illustrations show part of a line of quick-acting fixtures, designed for profiling, milling and drilling metal parts of a well known machine. We found that in the fixtures used previously, often more of the operator's time was taken in clamping and unclamping the work, than was consumed in the actual cutting operations.

There is nothing startling in the design of these fixtures except, perhaps, a little more tool work in the making of them than there would have been if simple screws, clamps, or eccentrics had been used to hold the work in place. But I wish to impress firmly the great saving in time, and consequent cost of manufacture brought about by the use of fixtures of this nature. The line of fixtures shown herewith is mostly for cutting brass, and as the cuts are made very quickly, the operator will spend the greater part of his time in placing and removing the work. The first fixture, Fig. 1, is a profile fixture for the cut, extending from *A* to *B*; the cut is about 12 inches long, not very heavy generally, excepting at the top part, a distance of about 5 inches where sometimes the castings come a little heavy at this place. This fixture consists of a cast-iron base 1 inch thick held to profile-machine

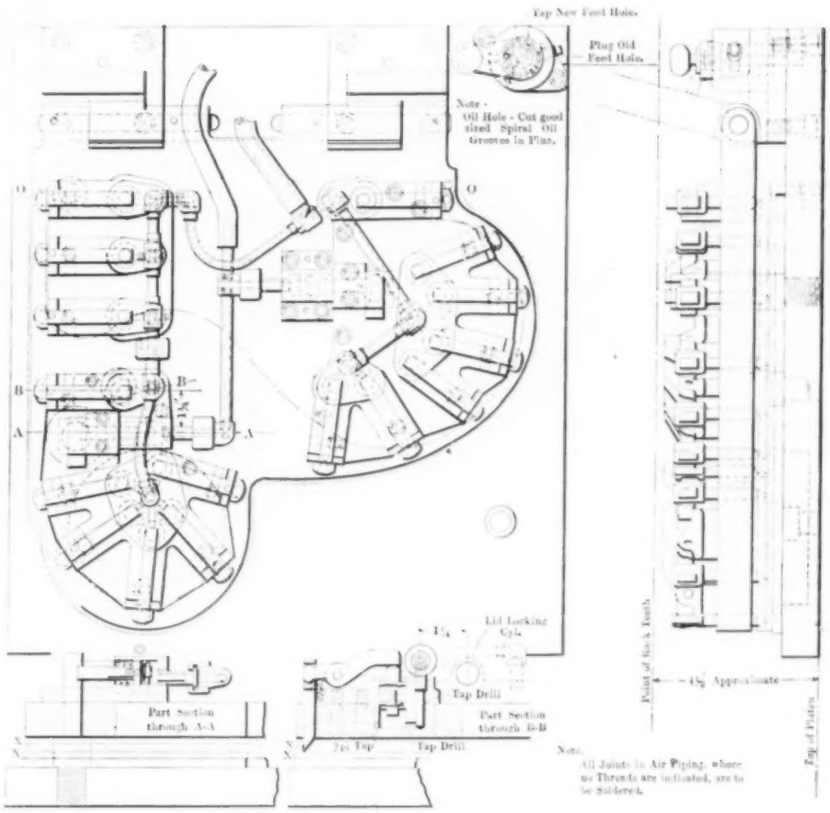

Tap New Feed Hole.
Plug Old Feed Hole.
Note - Oil Hole - Cut good sized Spiral Oil Grooves in Plan.
Lid Locking Cyl.
Tap Drill
Part Section through A-A
Part Section through B-B
Tap Drill
Point of Back Teeth
Approximate
Plug of Plates
All Joints in Air Piping, where no Threads are indicated, are to be Soldered.

FIG. 3. PNEUMATIC FIXTURE FOR HOLDING PROFILE WORK

*Head of tool designing department, National Cash Register Company.

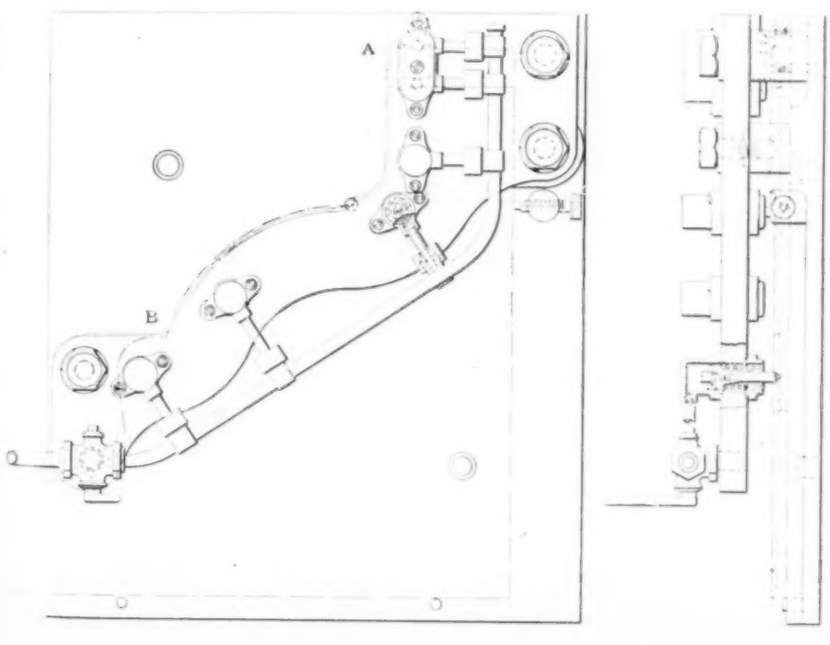


FIG. 1. PNEUMATIC FIXTURE FOR HOLDING PROFILE WORK

FIG. 2. ARBORS FOR PROFILE CUTTERS

platen by two fillister-head screws. On this base, held by three screws, is a machine-steel form plate 13/16 inch thick, which is carbonized and hardened on the tapered form surface at *A B*, on which the taper roll of the cutter arbor shown bears; this is made taper for adjusting the cut as the cutter is ground. The work is slid under this form plate, dropped over and against the two locating pins at bottom edge, and located sideways with nurled screw forcing the work against the pin which is cut away to fit the corner in casting as shown, then quickly touching the valve lever the work is clamped.

The fixture we had in use previously had five 3/8-inch screws for clamping the work. We paid 65 cents per hundred for the making of this cut, and an ex-

perienced man by working very hard, and pushing the job as much as possible, was enabled to make from $2.80 to $3 per day of 9 hours. We replaced the five 3/8-inch screws with the small plungers as shown worked by compressed air.

As they were made to clamp close to the working edge, we made them small, 13/16 inch diameter to clear the profile spindle, and making them small, naturally gave us very little pressure, but in a profile cut of this nature, the pressure of cutter is nearly all sideways. So we made our plungers with a pointed end like a center punch, and as this point enters the work about 1/32 inch we had no trouble whatever holding our work, the secret of it being the pointed clamps.

With the pneumatic fixture the operator could make the same pay with the price lowered to 30 cents. This fixture was made about four years ago, and effected such a saving over the old method that we immediately made three more about like it, for a similar cut on other sizes and we have experienced no trouble with these fixtures. The air pressure was supposed to be 80 pounds, although at that time the air plant was small and the pressure would sometimes get down to 50 or 60 pounds. We have now an air plant of ample size. Fig. 2 shows an arbor for cutters used to follow a form in profiling.

Holding a Weak Piece of Work

Fig. 3 is a profile fixture using a form cutter for the cut on surface marked *x x* in section, and extending around from *o* to *o* on a brass-plate casting of a shape as shown by the dot-and-dash line. This casting is narrow and weak at and near the ends *o o*. The fixture has a cast-iron base 1¼ inches thick, which is screwed to the profile platen. A machine-steel form plate with hardened straight-faced contour, used for guiding the cutter, swings on hinges to admit of placing the work, these hinges being at the right-hand side of the operator. This form plate is further guided and controlled by having two slots ¼ inch wide, which pass over, fitting sideways and bearing against the shoulder of the hardened-steel posts, as shown at *A A*. Inserted into clearance holes in this form plate are several bronze castings, being held to form plate with fillister screws. These castings have a number of 11/16-inch holes in them for operating the air pistons, which work through levers, as shown in section view. This also shows the center punch points and how they get close to the outer edge of the work. In addition to the cylinders operating the clamping points, we have two other 5/8-inch cylinder castings which operate the lock bolts holding the form plate to base of fixture, as shown at *A A*. The clamping cylinders are all connected by holes and piping to a small piece of rubber tube which leads to the valve in

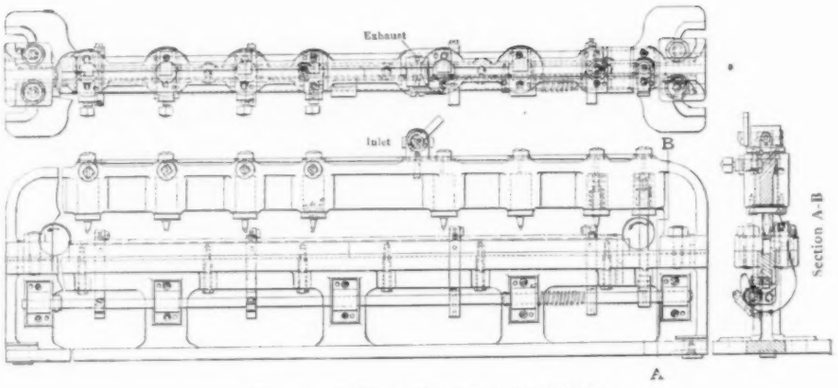


FIG. 5. FIXTURE FOR STRADDLE WORK

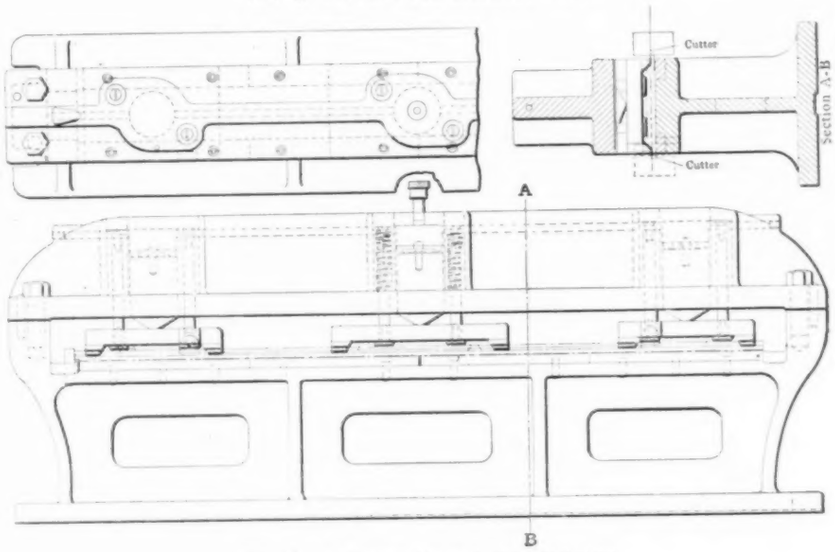


FIG. 6. ANOTHER DOUBLE-EDGE FIXTURE

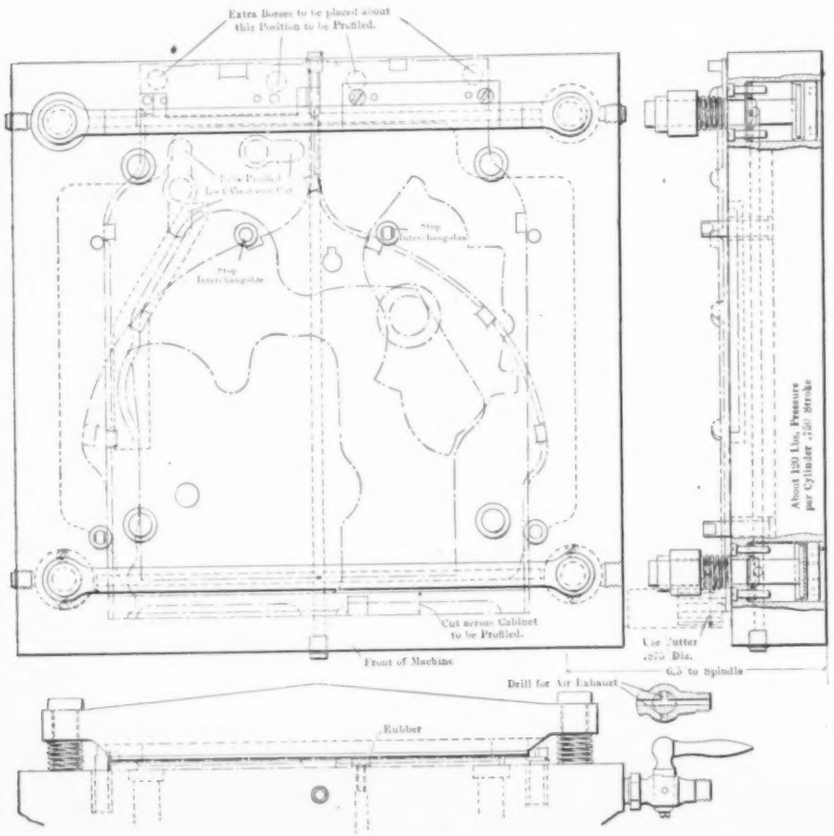

Extra Bosses to be placed about this Position to be Profiled.
Stop Interchangeable
Stop Interchangeable
Cut across Cabinet to be Profiled.
Front of Machine
About 120 Lbs. Pressure per Cylinder .750 Stroke
Use Cutter .875 Dia.
0.5 to Spindle
Drill for Air Exhaust
Rubber

FIG. 4. PNEUMATIC FIXTURE FOR HOLDING PROFILE WORK

the corner of the base of fixture. The two form-plate locking cylinders are connected to another piece of rubber tube, which also leads to the valve. The form plate being heavy, is raised and lowered for the admission of work by a very simple air hoist, which is not shown. The work which is shown finished, in a dot-and-dash-line, has a hole at *A A* which fits over locking post, and is swung against the pin at *o* for locating, the form plate being up at this time. Touching the air-hoist valve the form plate quickly and lightly drops to position. Next, touching the valve on corner of fixture first admits air to locking cylinders, and second, with the same movement admits air to all the clamping cylinders holding your work. To remove work, touch valve on corner of fixture, then touch hoist valve and take work out.

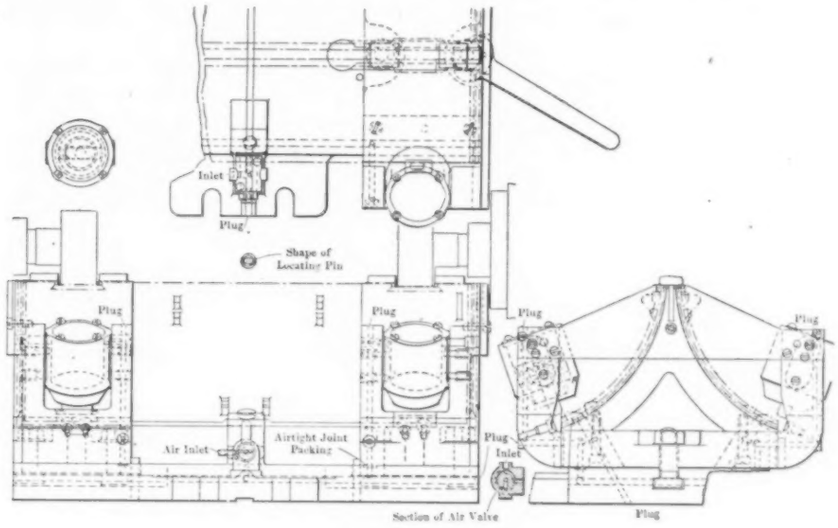


FIG. 7. HOLDING TWO PIECES AT ONCE

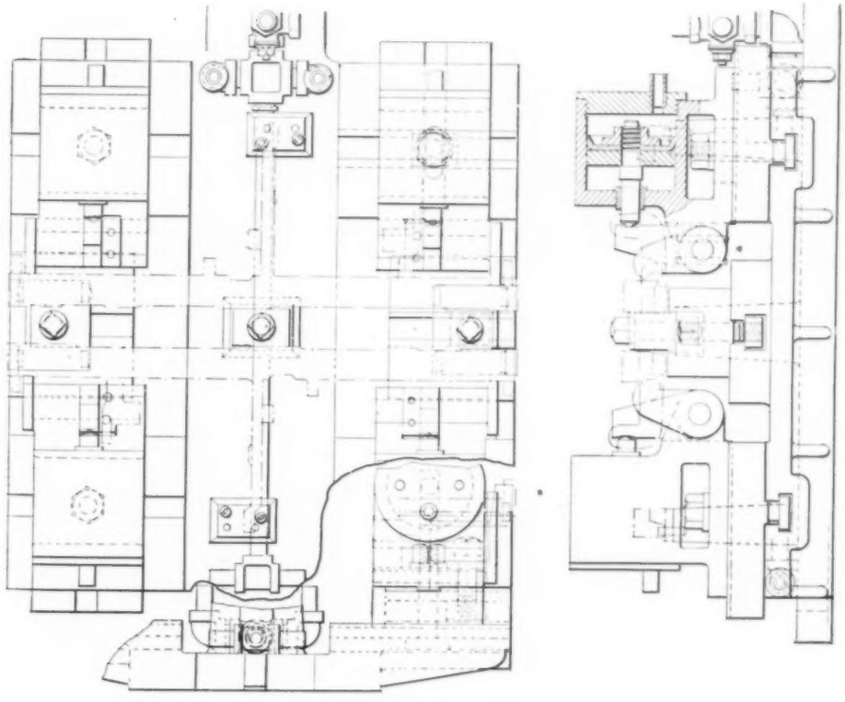


FIG. 8. A DIFFERENT METHOD

In the fixture we had in use previously the work was held by clamps and screws, without any lid, the work being slid under the form plate and clamped, and with this style of fixture we paid $1.80 per 100 for the making of this profile cut, but with the fixture as shown, using air, we were enabled to cut the price paid per 100 to 90 cents, and this enabled the same man to make the same rate as before.

Another Profile Fixture

Fig. 4 shows another style of profile fixture, for making some boss cuts at the back of fixture and a surface cut at the front of fixture as pointed out on the drawing. A right and left brass side plate, is shown by the dot-and-dash line in this fixture, although in use only one side plate is put in the fixture and operated on at a time.

The base of this fixture is cast iron $2\frac{3}{8}$ inches thick, cored out to lighten and with $4\frac{5}{8}\times1\frac{1}{2}$ inches diameter, counter-bored holes for the pistons to work in. The pistons in this case work at the bottom of the open cylinder hole, the cupped-leather packing being held in place by a washer and round nut underneath forcing against the shoulder of the round steel-headed screw which connects piston to clamping plate. This screw, or piston-rod is automatically packed at the top of cylinder bore by a reverse cupped-leather packing, held in place by a metal washer and screws as shown in section. When the air is shut off, the pistons are brought to their normal position by the two springs under each clamping plate.

The four cylinders are all connected together by three ¼-inch holes drilled through the cast-iron base, from side to side with a long shank drill, and having the outer openings closed with plug as shown. The steel clamping plates are slotted at the bottom with a ¼-inch width of slot in which is forced a long strip of medium hard rubber ¼x½-inch for clamping. This rubber is used to enable the clamp to accommodate itself to irregularities in thickness of work, and is also used largely to prevent marring any surface which is stippled, or where a clamp mark would show in the final finish. The valve in this case is shown in front at the right-hand side of the fixture.

Fixture for Double-head Milling

Fig. 5 shows a double-head mill fixture for milling simultaneously both sides of a brass casting about ½ inch square of a section as shown, and of five different lengths of about 9, 16, 18, 23 and 26 inches. The drawing shows the work, with cut finished, but in position ready to be clamped by a touch of the valve lever at the top of fixture. This fixture is about 34½ inches long over all, has a cast-iron base for clamping to platen, with a hardened machine-steel strip for supporting the work. The work is put in from one side against the adjustable stop arms, which are thrown into a fixed stopped position by the torsion spring surrounding the stop-arm carrying shaft. These arms have stop pins and adjustable screw stops for different widths of work to be milled, and are always in the stop position when work is ready to be put in.

Fastened with cap-screws to the base casting, is a cast-iron yoke which is drilled and reamed for eight 1-inch pistons, seven of these pistons having tool steel hardened center-punch points for clamping the work. The eighth cylinder is used to push the stopping arms out of the way of the cutters. The cutters are shown in the starting position,

and have a tendency to hold the work down and also against the stop pin shown. The air enters the valve through a short piece of rubber tubing, and when the valve is opened, the air passes to the seven clamping cylinders through a single ⅛-inch brass tube. The air also exhausts through this same tube, to a by-pass in the valve in releasing. Directly above each cylinder, this air-supply tube is punctured with a small hole packed with a piece of soft rubber and the air tube clamped at this point with the screw and plates shown. Four of these cylinders have air cut-off screws, at the side to save air when doing the shorter work. A second small brass tube leads from the valve to the end cylinder operating the adjustable stop arms previously mentioned. In operation, the stop arms being in position, the piece to be milled is placed in the fixture and the valve lever is moved. This single movement admits air first to all the clamping cylinders you wish to operate, and second to the cylinder removing the stopping arms from the path of the cutter. To release the air you move valve lever back. The use of air in place of screws cut the price of this straddle cut from $1.25 to 60 cents per hundred, with the same wages earned in both cases.

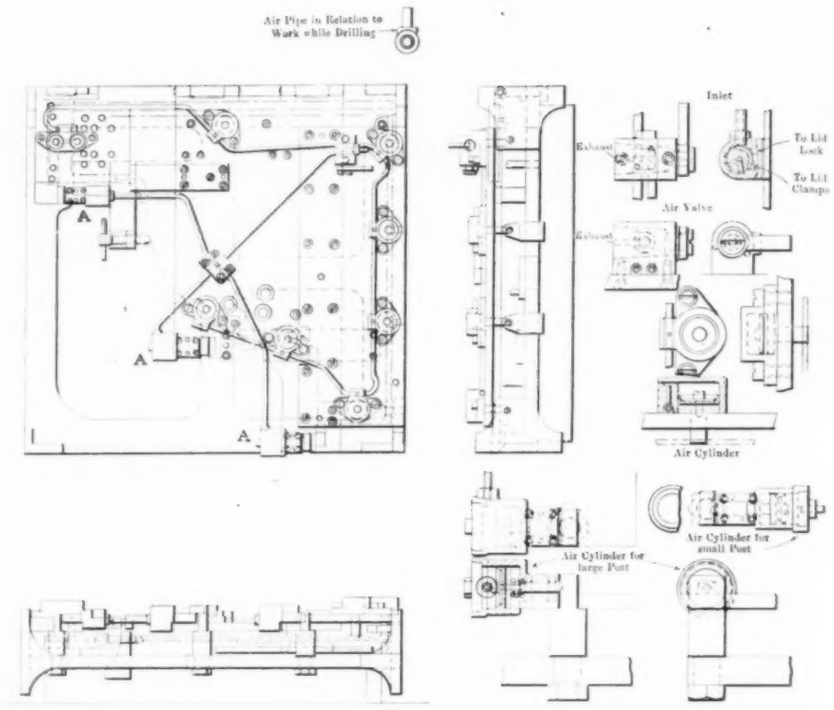


FIG. 11. A LARGE AIR FIXTURE

Where Straddle Mills are Used

In Fig. 6 we show a double-head milling fixture for making at one operation the cut shown in section at *x* and *x*. This cut is on a brass casting, and is nearly 26 inches in length, the thickness of cut being not over 5/32 inch. The work in these fixtures stands high, about 6 inches from the platen of the machine; the reason for this is to keep the adjustment of the cutter heads in practically the same up and down position for the operator, as in some of these fixtures for different cuts, the cutters must cut from underneath. The base of this fixture is cast iron with hardened bearing strips at the side for clamping the work on, the work being located sideways against stop pins on the border of work beneath.

The cast-iron yoke is fastened to the base by screws and pins, is bored out in three places on its underneath side for 1¾-inch pistons, which are simply cold-rolled pieces of shaft tapered on the lower end to bear against clamping plate, and having the usual cupped-leather packing held by a washer and screw at the top. At the side of each of these cylinder holes are two ⅜-inch holes drilled and counterbored from the top to ¾-inch diameter, for a coiled spring, connection of spring and clamp being made by the rod with screw in each end. The valve in this fixture is placed at the connection shown in the center, and has a rubber tube connecting to air-supply pipe. The air connection to the three cylinders is through a ¼-inch

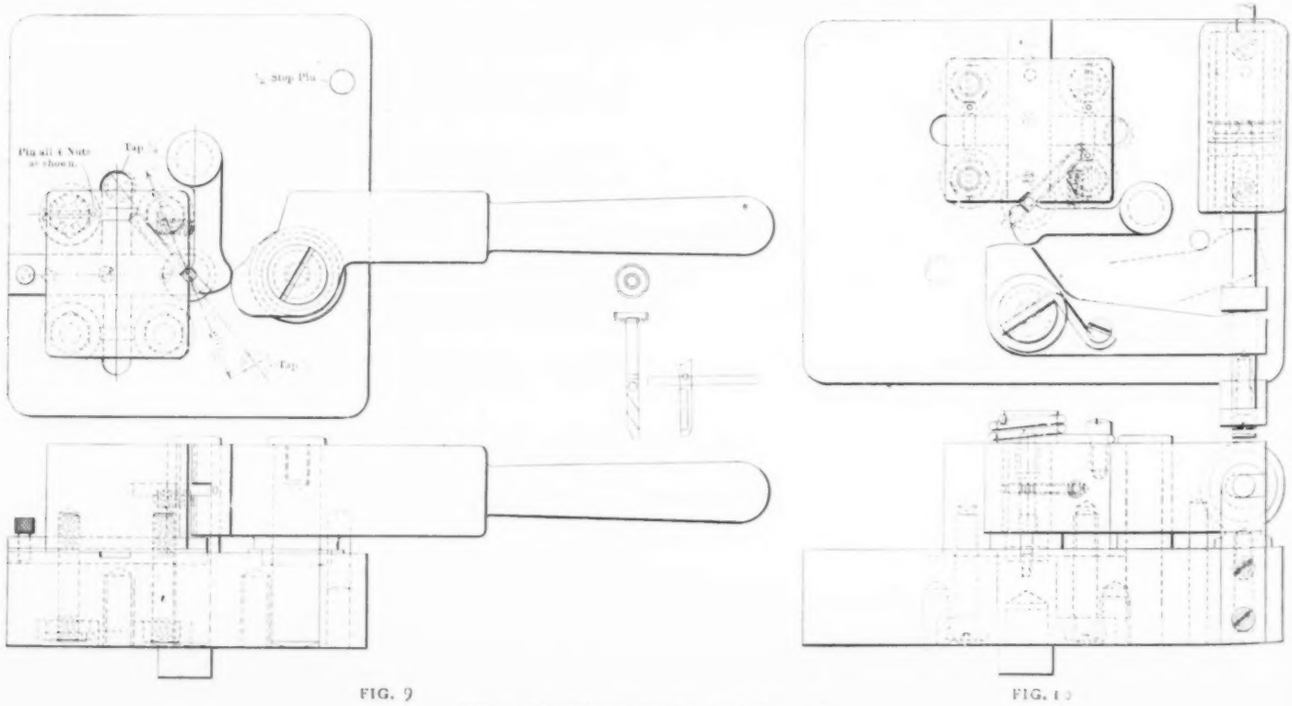


FIG. 9 FIG. 10

THE SAME JIG WITH AND WITHOUT AIR

hole drilled from each end of yoke, with the ends of holes plugged.

Holding Two Pieces at Once

Fig. 7 shows a fixture for making a hinge cut on each end of a curved brass cabinet lid of different lengths, the longest lid being about 19 inches. The fixture is designed to do two lids of the same length at a time, both hinge cuts being made simultaneously with a double-head mill, and the cutters being double interlocking with herring-bone teeth, this being done to make a smooth cut.

This fixture being made to do different lengths of lids, it is made with two clamping heads, made to slide toward the center of fixture, guided by a tongue, and held down to the cast-iron base plate by two bolts sliding in the T-slot in the base. On these clamping heads, a machine-steel forging, planed to fit the contour of the lids to be milled is fastened by screws. These lids come against case-hardened heads, formed on this forging at the top.

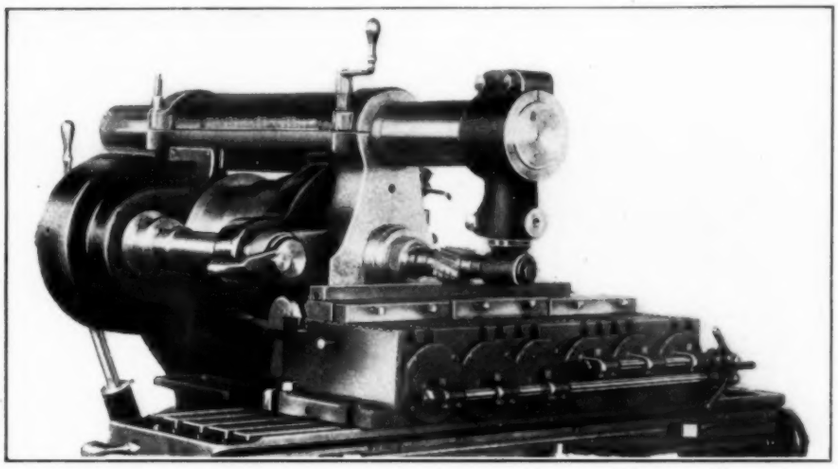


FIG. 12. PNEUMATIC MILLING JIG

This forging is stiffened by a plate, which is tongued and screwed to it, and further fastened to the clamping head at each side.

Each clamping head in a recess cored in each side has a cast-bronze cylinder of 2⅛-inch bore, fitted with the usual leather-cupped packed piston, carrying a clamping plunger 1¾ inches wide at the bottom which is beveled, forming a wedge between the work to be milled, and two hardened pins opposite. The work which is shown clamped in the fixture in a dot-and-dash line, is previously milled on the lower and upper edges.

To release this work, you simply touch the valve lever, shown on the base in front at the center which raises all four wedges, this being all there is to the clamping or unclamping of these two cabinet sides. The air-connecting holes are all made by drilling through the base and heads, leading to the four cylinders, and to the uninitiated, it is something uncanny to see a fixture of this kind clamp work without any visible connecting link. I wish to call attention to this peculiar method of clamping, for such a heavy cut as this as, from the end, it seems as though a cutter would push the other side away; but taking into account the point at the clamping wedge, it would have to swing from, it will be seen that it only holds the tighter.

Holding Tie Bars of Different Lengths

Fig. 8 is a fixture designed to mill the ends of two cast-iron tie bars at one time, and also to mill bars of different lengths. The drawing shows by a dot-and-dash line, two of the longest bars clamped in position. This fixture has a cast-iron base carrying four movable cylinders in which are the usual pistons as seen in the section, each piston having a steel plunger pointed and hardened on the end, which pushes against a lever that is keyed to a forged tool-steel shaft ¾ inch diameter, swinging in bearings, and having on the other end another lever forged on it. This lever has a knife edge hardened and bears against the work to be milled.

The work to be milled is supported at each end by a machine steel, carbonized and hardened block which is adjustable for the different lengths of tie bars to be milled, and is located with a tongue, and held to base by a single bolt. This bearing block is easily removed for other shapes suiting different work. The valve in this fixture is on the base and is connected to the four cylinders by short pieces of rubber tube which are joined to connections leading to a hole in the base.

These cylinders are made large, 3 inches diameter, as the cut is heavy, and the force of it comes directly against one of these bars, which must be counteracted by the air pressure. A single touch of a lever clamps these two tie bars, and a touch of the same lever releases them.

Before and After Taking Air

Figs. 9 and 10 show an example of before and after taking the air. In Fig. 9 is a fixture for riveting the round key cup to the round-shouldered end of a square-steel key. This key has a slot milled near the bottom end, and also a hole with a pin projecting from it near the center, making it weak at this lower end, as will be seen by looking at the detail of this key shown at the side of Fig. 10. These keys being weak must have a powerful clamping pressure applied to them to prevent them from springing by the action of the riveting machine forcing them down on their lower end. We hold these keys in a V with a V-shaped lever being clamped with a cam lever about 10 inches long. It is a simple movement to operate this lever, but it is tiresome and slow in comparison with the mere touch of an air valve. Fig. 10 shows how we doctored this fixture, by sticking a little air cylinder in one corner, connecting its piston-rod to a cam-shaped lever, when a light touch of the valve lever clamps or unclamps the work. This is not done for fun, but because it increases the output, and also insures the same clamping effect, preventing any springing of the keys brought about by the operator not putting sufficient clamping effort on the cam lever, shown in Fig. 9.

Air Applied to Large Jigs

Fig. 11 shows how we applied the air to several large jigs for drilling brass cabinet sides. The outline of one of these jigs is shown in a faint line, but it does not show any of the 13 bushings in the top or lid of this jig, or the four bushings for the base holes in cabinet side, located in the back side of the jig. There was also one bushing hole in the side opposite the lid hinges. These 18 holes are all drilled simultaneously on an automatic multiple-spindle drill press. This jig originally had five nurled headed screws in the lid for clamping the work, and also had screws in the lid-locating posts, which are fastened to the base; these screws clamped and unclamped the lid to the base of the jig, by a quarter turn. When using these screws we paid $1.25 for the drilling of 100 cabinet sides, but after applying three air-lid locks, and the nine air-clamping cylinders as shown, which all work with only a touch of a valve lever, we were enabled to cut the price to 52 cents per hundred, with the same man on the same machine earning the same wages in each case.

In these drill jigs we use a standard cast-bronze cylinder casting, being faced off on the end which is screwed to the top of the jig lid, this faced end having a projection in which is milled a ¼-inch slot round at the bottom and in this slot is the 3/16-inch outside diameter, brass air-supply tube, which is twined around like a string of putty to any cylinder you have in place and is then punctured with a 1/32-inch hole, packed around with soft rubber, the connection being held air tight with the two fillister-head screws which

also hold the cylinder. The details of the clamping cylinders, lid-locking cylinders and the air valve are all clearly shown in the sectional detail. These clamping cylinders, lid locks, valve and piping are all on the top of the lid jig, the valve is in one corner, and is connected to the air supply pipe by a rubber tube.

To operate this jig place the cabinet side in position, lower the lid, and touch the valve lever. This allows air to pass through the line of pipe to the three lid-locking cylinders *A A A*, and with only the one movement allows air to pass through the other line of piping connecting the nine clamping cylinders. The jig is then ready to roll to position under the 18 revolving drills. A backward movement

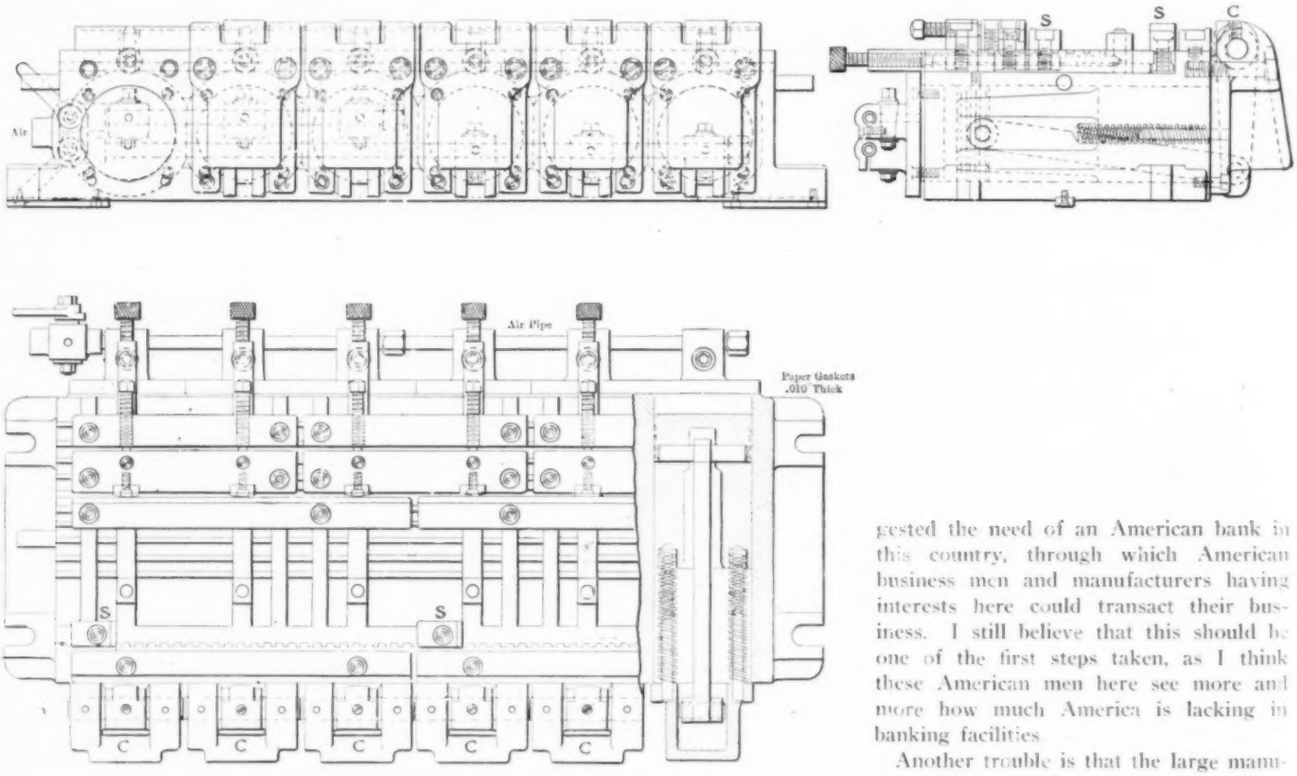


FIG. 13. DETAILS OF SIX-CYLINDER AIR FIXTURE

of the valve lever, unclamps the work, and then unlocks the lid.

In concluding, I would say we experience no trouble with these fixtures; they are rapid, and hold the work well, and in any of the departments where we place fixtures of any nature operated by air, the workmen like them, and the foremen naturally become so enthusiastic about them that in some cases they clamor to have all fixtures operated by air.

A Pneumatic Milling Jig

One of the milling jigs used by the Cincinnati Milling Machine Company is shown in Figs. 12 and 13. The first shows the general arrangement of the cylinders and jaws while Fig. 14 gives details of construction. There are six cylinders, three on each line of air pipe and in addition to cutting out either set of three, each cylinder has a separate cut-out in the shape of a plug cock. The pistons each have four packing rings; the connecting-rod runs from the wrist pin to the long arm of the clamping lever *C* and the pistons are returned by springs as shown. The cylinder heads are packed by paper gaskets about 0.01 inch thick.

The adjustable jaws are in front and can be moved anywhere across the face of the jig according to the work, the rigid stops fit into the small lengthwise slots and the inner jaws are adjusted to within clamping distance by the set-screws shown in both figures.

In addition to these there are end stops *S S* which take the end thrust of the cut and which fit into the side notches shown in the top view. These are important in any heavy milling work the same as in planing, especially with the heavy cuts and feeds of today, and they make it unnecessary to clamp the work with as much pressure as would be needed without them.

Experience with high-speed steel milling cutters for cutting nickel-chrome steel armor plate, and for cutting teeth for motor-car gears, which are made of a very hard material, putting a severe strain on the cutters, has shown that for such work the high-speed cutters will last three and one-half days without regrinding, as compared with one day when ordinary carbon-steel milling cutters are used, and at the same time allow an increase of one-third in the amount of feed per revolution.

Trade with Japan

By Chas. A. Francis.

I wish that your paper could stir up a little more pride in American manufacturers in regard to developing trade in the Orient; it has always been more or less an annoyance to me as an American since I have been in this country, to see how little enthusiasm manufacturers have in regard to this matter, and in my mind constantly since I have become more directly connected with manufacturing concerns.

In the issue of the American Machinist, on page 382, Vol. 28, Part 2, I suggested the need of an American bank in this country, through which American business men and manufacturers having interests here could transact their business. I still believe that this should be one of the first steps taken, as I think these American men here see more and more how much America is lacking in banking facilities.

Another trouble is that the large manufacturing companies of America do not get in touch with the users of machine tools in this country as they should, few representatives being sent here to push the sale of American goods. American manufacturers ship goods f.o.b., and extend but limited credit, and they are too apt to sit down at home and wait for orders for goods that they have made for home consumption in place of taking pains to learn what the people of the Orient would like to buy. If an order is sent for a standard article used in America, well and good, but should it vary in the least from this standard the manufacturers seem to be satisfied to let the order go elsewhere.

Manufacturers will have to expect much sharper competition and smaller profits than a few years ago, but nevertheless I believe that manufacturers can, if they so desire, compete with any country, for they have the knowledge and the capital to back them.

Notes on the Design of a 36x36-inch Planer

How Many of the Elements of the Design Were Determined by Computation and Many Others Decided Upon by Judgment

BY ENTROPY

A year ago—or was it two—I had the temerity to not only design a boring mill, but to take the readers of the AMERICAN MACHINIST into my confidence. I have only just recovered sufficiently from the scorn with which some of the correspondents of this paper received my views to feel like trying it again. This time it is a planer that I have been working on, and while I must confess that the things which have really influenced my decision between various designs are perhaps no more logical or scientific than were those used before, I have learned to find more scientific excuses than I did then. If any of your practical readers deem this article too theoretical and prefer to have something practical, I will refer them to page 303, Part 1, Volume 29, to set them at rest as to my natural inclinations.

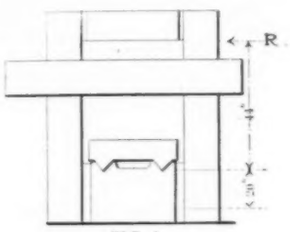


FIG. 1

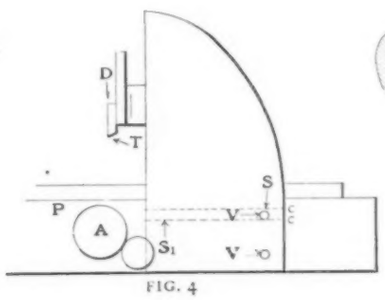


FIG. 4

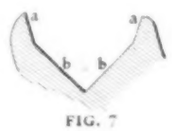


FIG. 7

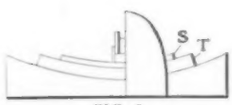


FIG. 2

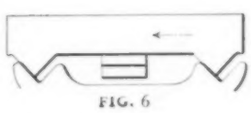


FIG. 6

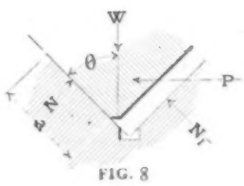


FIG. 8

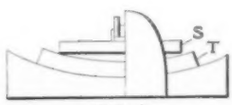


FIG. 3

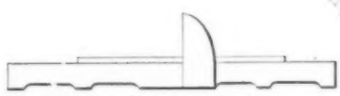


FIG. 5

SKETCHES RELATING TO THE DESIGN OF A 36X36-INCH PLANER

This planer was to be a 36x36-inch by any length that might be called for. It was to be about the middle of a series, and was expected to be a little better than any planer made by certain makers whose names it would not be safe for me to give.

GENERAL FEATURES OF THE DESIGN

The first move that we made was to sketch a rough front view, Fig. 1, not to scale, but simply to give us something to look at and hold our attention. The width of opening between the posts (housings or uprights, as you please) was taken as 37 inches; the depth of the opening under the arch or top brace was taken the same. This was to allow for poor or swollen castings, as well as for ordinary finish.

The hight from the floor to the top of the table for convenient working has been found by experience to be about 30 inches. Whether to use the whole of this depth for table and bed or to put the bed on short legs was our first question. The main argument in favor of legs proved to be that it would be easier to get the chips out from under the bed. The arguments in favor of a box bed were that it would prove to be a strong talking point to show the extreme depth of bed, and that it would really cost no more to make the bed deeper than to plane the legs, drill and bolt them in place and turn the bed over. As for the chips, we would not have to get them out anyway. If the buyer used our advice we would suggest to him that if his planer was to set on a foundation there ought to be a pit under it into which a man might go to look after the gearing, also that this pit could be easily arranged to take most of the chips since most of them fall within a short distance of the tool.

Then we had to decide in a general way what the relative stiffness of the bed and table should be. It may sound heretical, but we decided against an extremely stiff table. We sketched a planer like Fig. 2 with a rigid bed planed out on a circle (exaggerated, of course). On this we placed a flexible table and likewise a flexible piece of work. We saw no reason why the work should not be well done provided it was perfectly elastic. Then we changed to Fig. 3, which is the same planer with a rigid piece of work S resting on its ends on the table. Here it was evident that we would get a piece of work planed to just the curve of the planer bed, provided the table was locally stiff enough so that the bolts holding the work would not spring the table off the bed. The conditions that we decided necessary were these: The bed should be straight; the table should be flexible enough to lay down fair on the bed; it should be locally stiff enough so that it would not be sprung locally away from the bed by the holding-down bolts. If we used only short beds they could be put in a state of equilibrium by resting them on three points, as is done with some small tools. Then any change in the foundation on which they rested would not affect their straightness. But this planer was to be built with any length of bed from about 12 feet up.

We decided to make the central part of the planer heavy and rigid, so that the tendency of the cutting tool to chatter would be as little as possible, and to make the ends of the bed supports to carry the table. We decided to make these ends sufficiently flexible to be lined up readily if the floor on which they rested settled. If this planer rested on a stone or concrete foundation, why it would never settle (?). There are no forces acting on these ends except the downward pressure due to the table and the work; these forces act only to compress the material of the bed. There is nothing else to disturb their alinement.

The central part of the planer may be represented as in Fig. 4 where the bull gear, or rack gear A, pushes the table to the right and the tool exerts a force T to the left with a smaller force D downward to force the tool to its cut. This latter force may be nothing, or it may become an upward force under some conditions. These two forces T and D are balanced by P and by the upward pressure of the bed on the table, or by the weight of the table and work if D is upward. None of these forces has any effect on the ends of the bed, but they do require all the stiffness possible within the limits of the figure. Under these circumstances we decided to make the projecting ends of the bed shallower except where feet were to be cast as in Fig. 5. We took care of

the chip question in this way and lightened the bed casting at the same time.

The Table

Our attention was again turned to the table. We had decided that it must be stiff against bending from bolting down work, but not too stiff for it to lay down properly on the bed. This proved to be a ticklish point to decide; for if we could depend on the planer always being used properly almost any thickness that would hold together would be enough. To make it fool-proof meant to make it deep, but cored out so as to be light. On the other hand a heavy, solid table would better absorb vibration and lay down better on the bed. A deep table would be a good talking point. Our final decision was prompted about equally by all these factors. We made it deep; six inches over the sides of the vees. We made the body of the table solid and put in very light ribs for the rest of the depth. It was made to look deep and rigid, yet to be quite as flexible as if it were two inches shallower; at the same time it was to be heavy enough to absorb a good deal of vibration. The process by which we arrived at the six inches was to hold up a rule, squint at it, look wise and say that it looked "about right." The actual weight of the table did not give us much concern at that time except as we had to pay for the iron. We expected little trouble from the momentum of the table itself as compared with that of the more rapidly revolving driving pulleys.

Before we could get the actual cross-section of either bed or table we had to consider the bearing surfaces between them. The only choice of form seemed to be between two vees and one vee and one flat way. The flat way affected in England appeared to be out of the question owing to the necessity of making a salable tool, to say nothing of the objectionable feature of difficulty in taking care of wear. We inclined at first to try one vee and one flatway. There certainly is no need of but one grinding surface—if there is need of more supporting surfaces—provided the power to move the table can be applied directly over or under the guide. It was this last consideration that settled us in favor of the two vees. With a bed having two vees and a rack drive half way between them, there would be no tendency for the drive to push the table harder against one side of the vees than the other. Moreover, I realized from painful experience that it costs no more, if as much, to accurately fit a two-vee bed and slide than it does one vee and a flatway.

The angle of the vee was the next thing. The only object of the vee is to prevent side motion. With a square side and a flat vee it would be absolutely prevented, but with such a slide wear would not be taken up automatically as with the vee. With the latter, unless there is side pressure, the table will settle to its lowest possible position. It cannot move sideways without rising. If its weight is sufficient to hold it down against the greatest side thrust acting upon it, then it is just as secure as if it were gibbed down and bolted. In the Sellers' planer the side pressure is taken care of, as in Fig. 7, by little side bearings *a a*. Normally these do not take any wear; that is carried by the vee proper *b b*. If any pressure on the table is sufficient to slide it sidewise, it is brought against *a*, or *a* and stops. If it is used under constant side pressure ultimately *a* will wear and then the table can lift before it brings up against *a*; then it is no better than if *a* were not there—at least as to accuracy. Again, this feature may be patented.

To determine the greatest probable side thrust we had first to determine on the chip that we expected to be able to take. The Manchester experiments seemed to indicate that a pressure of about 115 tons per square inch of cross-section of metal removed was to be expected. Later experiments at the University of Illinois seem to show that less than half of this is required; Mr. Taylor's experiments show a range of from 35 to 100 tons. We figured on 60 tons per square inch as liberal for the ordinary run of castings that would be accepted in machine shops. To remove a square inch cross-section of cast iron at one cut is quite a stunt. Figuring on a basis of 20 feet cut per minute and 60 tons per square inch removed, and not allowing anything for friction of the machine, this called for about 73 horse-power. After discussing various phases of the question of gearing we decided to look into the driving belt.

We decided that we ought not to use a driving belt running at over 4000 feet per minute, and that nothing over 2½ inches wide would shift as easily and promptly as we wanted. This last opinion was derived from some of my past experience with wider belts. Of course, there is a limit to the driving power of a shifting belt planer which accounts for the numerous pneumatic and electric clutch planers among the larger sizes. But we felt sure of our ground up to the limit stated. We used the ordinary shop formula: One inch of single belt running 1000 feet per minute will carry one horse-power. If we decided to use a quick return of two to one, which was all that we dared with the prospect of some cutting speeds as high as 60 feet per minute, we could use only 2000 feet per minute for the speed of the cutting belt. This gave us immediately 100 to 1 for our speed ratio of table to belt on the slow speed with 50 and 33⅓ to 1 for 40 and 60 feet per minute respectively, on the cut. With a double belt this gave us 10 horse-power to drive the machine. This we judged to be ample from the point of view of the man who furnished the power. A fair allowance for friction seemed to be between two and three horse-power, which left a little over seven effective horse-power. We had found 73 horse-power required to remove a square inch cross-section, so now we figured on actually removing 1/10 of a square inch. This divided between two heads on the rail allowed for a cut on each of ½ inch deep and a feed of 10 per inch. The allowable pressure on the cut would be six tons or 12,000 pounds.

The Ways

The Nicholson experiments seemed to indicate that the pressure of the tool normal to the work to hold it up to the cut could be safely taken at 10 per cent. of the cutting pressure. We have all seen tools that would draw into the cut making a negative pressure. On the other hand, we have seen that Mr. Taylor recommends that the feeding mechanism of a lathe be made as strong as the driving mechanism. We took 20 per cent. of the cutting pressure or 2400 pounds as the maximum side thrust for which we would design the table. This allowed a margin for the use of fairly dull tools. To go further seemed to us too radical a step to take. It was not considered safe to rely on any part of the weight of the work helping to hold down the table.

The heaviest side pressure might easily be in shaving off one side of the head of a piece of railroad iron, where the weight of the work would be very little.

We drew Fig. 8 in which W represented the weight acting down on the table, N the normal force between the two surfaces in contact, P the side pressure (2400 pounds)

$$N \sin. \theta = W \text{ and } N \cos. \theta = P.$$

Then

$$tan. \theta = \frac{W}{P}, \text{ if } \theta = 45 \text{ degrees}$$

W must equal P. In this case the table must weigh 2400 pounds. The shortest length of table that we had to provide for was 8 feet which allowed us to use a table weighing 300 pounds per foot. To get θ up to 60 degrees which we rather wanted to use we had to get W up to 4150 pounds, or 520 pounds per foot. The choice of angle did not seem to us to be an important matter, as it only affected the power to overcome the friction of the bed on the ways, which we expected would be a rather small part of the whole friction loss. The advantage of the wide angle to us lay in its value as a talking point. To decide we had to find the relation between the area of the bearing and the angle. We drew, in Fig. 8, N_1 on the other side and lettered the width of one side of one vee *a*. Then

$$W = 2\,N \sin. \theta, \text{ or } 2\,N = \frac{W}{\sin. \theta},$$

$$\text{if } N = N_1,$$

which is true if there is no side pressure. This is for one vee alone. The limiting pressures between these two slanting surfaces must be less than on a flat surface.

since the tendency is for the oil to run down into the bottom of the vee, possibly as low as 40 pounds per square inch when fully loaded.

We thought it extremely unlikely that this planer would ever be loaded to its full capacity, a solid block of metal 36 inches square and 8 feet long, but it seemed to be perfectly possible that it might carry some heavy piece laid crosswise of the table which might bring as great a pressure per square inch on the ways as would the total possible load. A piece of cast iron 36x36x12 inches would weigh about 4000 pounds and the table would weigh 300 to 500 pounds per foot, giving us a total weight of from 4300 to 4500 pounds per foot. If the ways were flat, 40 pounds per square inch limiting pressure called for a total width (both ways) of 9 to 9¼ inches. This afforded us sufficient indication that our results would be reasonable, so that we worked out the width a of the sloping sides as follows:

$$40 = \frac{2N}{4a \times 12},$$

where N is the normal pressure on one side of one vee and a the width of one face of one vee. Since we found above that

$$2N = \frac{W}{\sin. \theta}$$

we combined the two equations and got

$$40 = \frac{W}{48\, a \sin. \theta}, \text{ or } a = \frac{W}{192 \sin. \theta}.$$

First taking $\theta = 45$ degrees and $W = 4300$, we solved for a, equal to 3.17 inches. Taking $\theta = 60$ degrees and $W = 4500$, we found a to be 2.7 inches. We allowed for an oil groove at the bottom ⅜ inch wide and computed the width across the top of the vee as 4⅞ inches and 5.05 inches respectively; the way having the least bearing area being the wider.

I shall have to confess here that we liked the 60-degree angle, but that we dropped it when we found how much more metal we would have to put into the table and how little difference it made in the necessary width of the vee. I shall also have to confess that we were led to use 40 pounds per square inch for our limiting pressure from a series of computations which I had made previously in a number of planers that seemed to stand up well in use. These showed an average of about 50 pounds when figured in the same way; that is, neglecting the pressure of the tool both downward and sideways. However, most planers will show some scoring of the vees if run on short work for a long time, hence we tried 40 pounds per square inch.

Deciding on a 45-degree vee made our 300 pounds per foot table possible. To get this weight in a table 34 inches wide, to allow 1½ inches clearance on each side for the dogs, called for an average thickness of metal of 3 inches, which we placed as in Fig. 9. The T-slots are not shown,

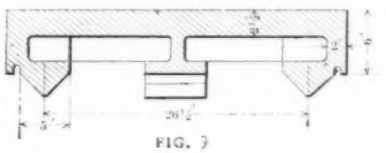


FIG. 9

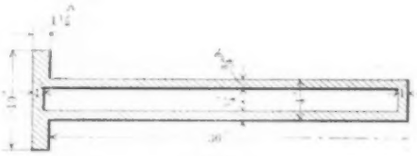


FIG. 11

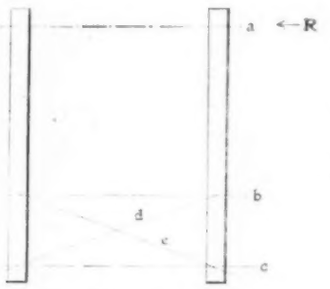


FIG. 10

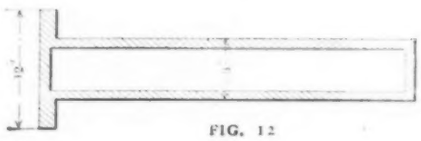


FIG. 12

SKETCHES RELATING TO THE DESIGN OF A 36X36-INCH PLANER

as the limits of such an article preclude the possibility of taking up a mass of detail that would nevertheless be very interesting to consider.

The Bed

The design of the bed again claimed our attention. The ends we had already decided to make as light as possible, but the center, the business part, we wanted to make sure was as stiff as could be asked for. Looking at Fig. 4, if we consider that $c\,c$ is a key let into both the cheek of the bed and the side of the post then $s\,s$ will represent the pressure of the post on the bed due to D, P and I, and $v\,v$ will represent the forces acting on the bolts (we used more than two) tending to shear them off. Faces $v\,v$ are equal to T and do not depend on the hight of T above the table. Forces s and s are due to both D, P and T, and are greatest under a given cut when the tool is at its highest point. It is obvious that the wider the base of the post the less will be the stress on $c\,c$, but on the other hand, the further apart $s\,s$ and A are the greater the opportunity for yielding due to the spring of the bed, since it then becomes practically a beam loaded at A and s and supported at s. Keeping Fig. 4 in mind, we went ahead with our design. We considered first the advisability of carrying the cheek well forward and the post with it, so that the bearing for the rack gear should come in the post itself. The objection to this scheme came in the fact that it would make the shaft carrying the rack gear so long that it would be springy. The additional defect was that this projection of the post would be in the way of the operator's knees. We did the next best thing by carrying the post and the cheek nearly to the rack-gear bearing, thus placing the face s as near a as possible, and by using a shaft to carry the rack gear strongly braced to the bed itself.

The Housings

To take up the tendency of the post to slide back on the cheeks, and to take care of the side stress on the posts we put in six 1¼-inch bolts on each side. What we really had was a beam on each side of the planer about 24 inches deep, at least 2 inches thick and 4 feet long, with the load only 6 inches from one end. We made the width of the post 36 inches from its face back. Anything larger looked "dumpy," and custom appears to be satisfied with this proportion. The computed deflection of this beam appeared to be practically negligible, so small in fact that if we used it at all we ought to compute the crushing effect of the pressures at $s\,s$ and a. Then we looked into the side pressures on the posts. If in Fig. 1 all the cutting tools were at the top and ground so as to produce the maximum side pressure of 2400 pounds; if only one tool was used its most unfavorable position would be at one end of the cross-rail and it would produce a lengthwise thrust of 12,000 pounds.

We assumed a cross-section for the post as in Fig. 4. The deflection of a cantilever loaded at the end only is $\frac{1}{3}\frac{Pl^3}{EI}$, where P is the load, l the length in inches (we took this as 50 inches since the real point of support is where the wedges come), E the modulus of elasticity (13,000,000 for cast iron), and I the moment of inertia about an axis through the center of gravity of the cross-section and perpendicular to the direction of the applied force.

With the 12,000-pound applied force we found the deflection to be 0.003 inch, which would be true if the section had been a rectangle and of the same cross-section all the way up. If we make the outline of the back of the post a parabola, which would give the greatest strength with a given weight, then the deflection would be twice as great. The section cannot be uniform, however, as the thickness of the walls would remain the same all the way up, which would slightly decrease the deflection. This deflection surprised

us, but we remembered that we were dealing with the tool under the most unfavorable conditions, and the design shown is not far from that successfully used on many planers.

Then we figured the deflection sidewise in the same way. Our maximum side thrust was 2400 pounds. No matter how we placed the tool we could not help dividing this face between the two posts if we used a reasonable tie or arch between them. In this case P was 1200 pounds and l only 40 inches, owing to the upper row of bolts above the key and between the post and cheek; I was taken about an axis at right angles to the former one and figured 272. The deflection figured 0.007 inch. The real deflection would be more on account of the decreasing size of the cross-section as we go upward on the post, but it would also be less on account of the stiffening effect of the cross-tie at the top.

It would still remain in excess of double the deflection the other way. This plainly showed us that we should make the cross-section stiffer against side pressures. We had also to bear in mind that we could not measure the deflections of different parts of this planer and take the greatest deflection as the measure of its lack of stiffness as a whole. The strength of a chain is measured by that of its weakest link, but its stretch is the sum of the stretch of all its links, weak and strong.

After repeated trials we struck on the section for the post shown in Fig. 12. It is two inches wider than the other in every part except the thickness of the sides. The I for this section proved to be 594, more than double its former value. It reduced the computed deflection to 0.0032 inch, which seemed to us to be fully as large as we ought to allow.

The fastening of the post to the bed next demanded attention. It is apparent from Figs. 1 and 4 that if the pressure R is exerted as shown the bolts fastening the posts to the bed will be in tension at the bottom, on the right-hand side at the top, and on the left-hand side at the top. If the pressure of R (2400 pounds) is considered equally divided between the two posts then the greatest tension will fall on the upper left-hand bolts and, of course, the larger part will fall on the nearer bolts. Having allowed for three bolts in a row we will consider all the side force to be taken by the two nearest the front. The longer the bolts the more they will give under a given load. To shorten the bolts means to make the thickness of the post less. This we have already seen means that we will make the post deflect more. We had already decided to make the total thickness of the post six inches, and to make the cheek equally strong we had to make it another six inches thick, giving a bolt 12 inches long.

We then tried to set a limit to the stretch. The spring at the top of the post would be $\frac{64}{10}$, or more than three times the spring of the bolt. Likewise the pressure on the bolt would be $\frac{64}{28}$ of that at the top of the post, or $\frac{64}{28} \times 1200 = 3840$ pounds. We decided to limit this spring at the top of the post to another 0.003 inch which would allow of a stretch of practically 0.001 inch on the bolts. Taking $E = 30{,}000{,}000$ we figured the stretch to be

$$\frac{3840 \times 12 \times area}{30{,}000{,}000} \times \frac{1}{1000},$$

$$area = \frac{250}{384}$$ square inch, or about 1 inch in diameter at the root of the thread if only one bolt were used. This corresponds to a 1¼-inch bolt and from our figures we would judge that one pair on a side would answer. Since we would hardly wish to use smaller bolts owing to the danger of twisting them off, we decided to at least halve this deflection at the top of the post by putting in all the bolts of this size.

We also realized that it would be difficult to tell just what tension we were putting on the bolts. If it were not for friction a pull of 100 pounds on a 12-inch wrench on one of these bolts should put a stress of 60,000 pounds on the bolt. As a matter of fact the friction of the threads and the friction of the nut on the face of the casting take up from 80 to 90 per cent. of this pressure, so that an effective pull of 6000 to 12,000 pounds is all that remains.

Cross Braces of the Bed

Next we had to provide the bed with cross braces to stiffen it against these side thrusts. We drew Fig. 10 representing the front view of these two posts joined by three light rods a, b and c. If the pressures are self-contained then a pressure R at the top would easily swing the whole frame over to the left, the only opposition is the slight stiffness of the rods. The space between a and b must be left open for the table and work to pass through. Usually more or less of an opening is left between b and c for the gearing. The most natural bracing would be the crossed tie rods or struts d and e. A little help in making the thing stiff could be expected from the tie or arch bar at a if made, as usual, nearly as deep as the cross-rail, but most of the stiffness must be between b and c. We tried to see if we could get along without cutting out this cross-tie at all.

It is the custom to use a bull gear, or rack gear directly under the cutting tool about as large as possible, for the ostensible reason that the teeth on a large gear are stronger and have less lifting action on the table than those of a pinion. We doubted whether there was much truth in this reasoning for the pinion meshing into the gear would have no more strength than if it meshed directly with the rack, and if involute teeth were used the obliquity of action between them would be the same for all mating gears, large or small. We concluded that the reason for using a large rack gear was to get the shaft on which the driving pinion was located down low enough so that it could either be set under the table or else, if placed outside, so that work bolted to the table and projecting over to one side would clear the gear.

After making a few sketches we decided that a 16-inch rack gear would give us the needed drop of the pinion shaft. We took the distance from the center of the shaft back to the front of the uprights as 12 inches, the same as the distance of the tool in front of the uprights. This latter distance we got from our sketches of the cross-rail and heads, which the limits of this article will not allow us to reproduce. We found that by putting the cross-tie only slightly to the rear of the face of the posts we would have ample room for the driving pinion, but before we could definitely determine its size we had to settle on the pitch.

We began with our maximum pull of 12,000 pounds. We guessed the second time trying 6 inches for the width for the rack, or 2000 pounds per inch of width. This is about what the Lewis formula allows for steel working at 18,000 pounds per square inch fiber stress for a 2-pitch rack. Our rack gear would have 32 teeth, 2-pitch and the smallest size driving pinion allowable considering conditions of wear would be 14 teeth, 2-pitch, or 7 inches pitch diameter. These dimensions confirmed our opinion as to the possibility of having a solid tie across the bed. We made this tie 6 inches wide, cored out to one inch in thickness. We had no very good reason to give for coring out this tie at all, nor for settling on its thickness. The tie acts very much like the web of an I-beam to resist a shearing force equal to the tension on the bolts which fasten the posts to the bed, which it may do by acting diagonally like the tie rods in Fig. 10, or in compression in corresponding directions. The very mass of this cross-tie may be expected to absorb vibration, and is in just the place where vibration may reasonably be expected and may do harm.

We decided that the other ties were a question more of appearance and value as talking points than in any other way. A planer bed is not like a lathe bed subject to torsional stresses, but simply acts like a beam to carry loads. Ties are necessary, but not as necessary as in a lathe bed. Our decision was to make the ties about 10 inches wide, spaced about 30 inches centers and cored out as thin as the foundry man would run them.

The Gearing

The gearing we had already begun to design for we had settled on the rack gear and the pinion meshing with it.

which we called the rack pinion. Usually planer gearing ratios are expressed as so many feet of belt to foot of table, and run from 30 to 1 to 100 to 1. A high belt speed is desirable so that the belts may shift easily and also shift reliably. To secure the latter feature the belt speed must be high to transmit the necessary power with a narrow belt. A high belt speed we found could be obtained by a moderately rotating shaft and a large pulley, or by a small pulley and a rapidly revolving shaft. The first meant a low speed of gearing and a large momentum for the pulley to overcome at reversal; the latter meant a less easily handled gear speed and a smaller momentum of the pulley. The momentum of the table did not trouble us at all after we made a few figures.

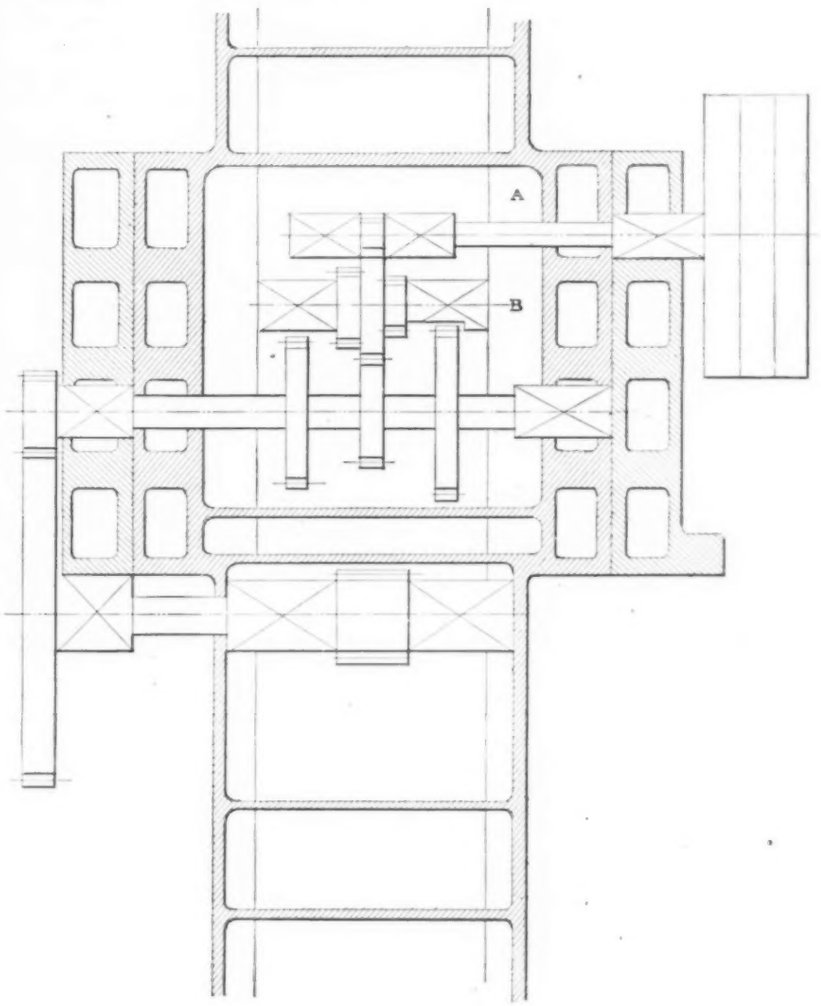


FIG. 13. ARRANGEMENT OF GEARING FOR A 36X36-INCH PLANER

The energy in a moving body is equal to its mass times its velocity squared. The table for the shortest length that we were considering was 8 feet long and weighed 2400 pounds. The speeds that we thought best to design for were 20, 40 and 60 feet per minute on the cut, and twice these speeds for the reverse.

We debated long over the point whether we would try for a constant return speed and a variable cutting speed. If we used a variable speed of cut with a constant speed return it would necessitate a variable-speed countershaft for the cut, which in turn would mean that the power transmitted by the belt to the planer would vary with the speed of cut. This would preserve a constant capacity as to chip at all speeds limited by the capacity at the highest speed. With the constant-speed countershaft and varying speeds of cut and return changed in the gearing of the planer itself we would have a corresponding increase in size of chip, which we could carry varying inversely as the speed.

The design of the train of gearing between the driving shaft and the rack pinion was mostly a case of trying to get the gearing into the space allotted to it. See Fig. 13. Shaft *A* carrying the 24-inch driving pulleys drives shaft *B* through a 12-toothed, 4-pitch gear and a 36-toothed gear. The speed of the pitch lines of these two gears figured about 500 feet per minute. The size of the shaft necessitated a pinion made on the shaft, and, therefore of steel. The 36-toothed gear on the shaft *B* had also to be made of steel, since someone would be sure to try to throw over the different speeds without shutting off the power. At these speeds we thought it best to case-harden the teeth of the shifting gears. The pitches and widths of face were gotten from the Lewis formula.

No allowance was made, nor did we find any made in the planers on the market for shock in reversal. The reason for this is evident if we compute the energy of the moving planer table and also that of the revolving pulley. The first weighed 2400 pounds (for an 8-foot planer); its greatest velocity was 120 feet per minute. Its energy, $\frac{1}{2} m v^2$, is 150. The pulley rim if three inches wide and ¼ inch thick weighs 14 pounds, its velocity is 4000 feet per minute, its energy on the same basis reduced to revolutions per second is 962, or more than six times as great. If we assume the 2½-inch driving belt to be under a tension of 140 pounds per inch of width, which very likely may be exceeded, then the sum of the tensions in the two sides will be 700 pounds. If the coefficient of friction at slipping is assumed to be 0.5, which is sufficiently on the safe side to allow for centrifugal force, then the two tensions when working will be 580 and 120 pounds each, giving a difference in tension or effective pull of 460 pounds.

This will overcome the energy of the pulley rim, 962 foot-pounds, in 2.1 feet, and that of the table in 1/6 the distance less what the friction of the table on the ways aids it, or about 4 inches. Thus the belt will slip over about 20 inches of pulley to stop or start the table on its fastest stroke and, of course, only ¼ as much on the stroke that is only one-half as fast. This amount may be decreased somewhat by the elasticity of the shafts and of the belt itself, but we could not imagine any way in which we could avoid some slipping of the belt on the pulley. Theoretically an india rubber belt of just the right elasticity ought to accomplish this result, but even then we would have to have a different belt for each change of speeds.

We did not look for any serious squealing of the belt unless the pulley was actually stalled which does not seem likely to happen. So long as a pulley keeps turning there does not seem to be much noise. By the way, at the instant of reversal there seems to be a "peak" load of

$$\frac{460 \times 4000}{33{,}000} = 56$$

horse-power. Pretty sizeable! But it all depends on how tight the belts are laced.

Of course many other things had to be given consideration. I have sketched over the things which seemed to us most important as we went over the design. I may be able to pick out a few more things from my notes later, but for the present I have probably gotten close up to the limit of my readers' patience.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Double-action Tools for Foot Press

The accompanying drawings show a set of tools fitted to an ordinary foot press. The tools are designed in such a way as to obtain a double action of the punch by each single push on the foot lever. The foot press fitted up in this way can be used for the rapid production of small and medium-size drawn cups and shells, of thin-gage metal, paper, or other materials, the work being blanked and drawn at one stroke.

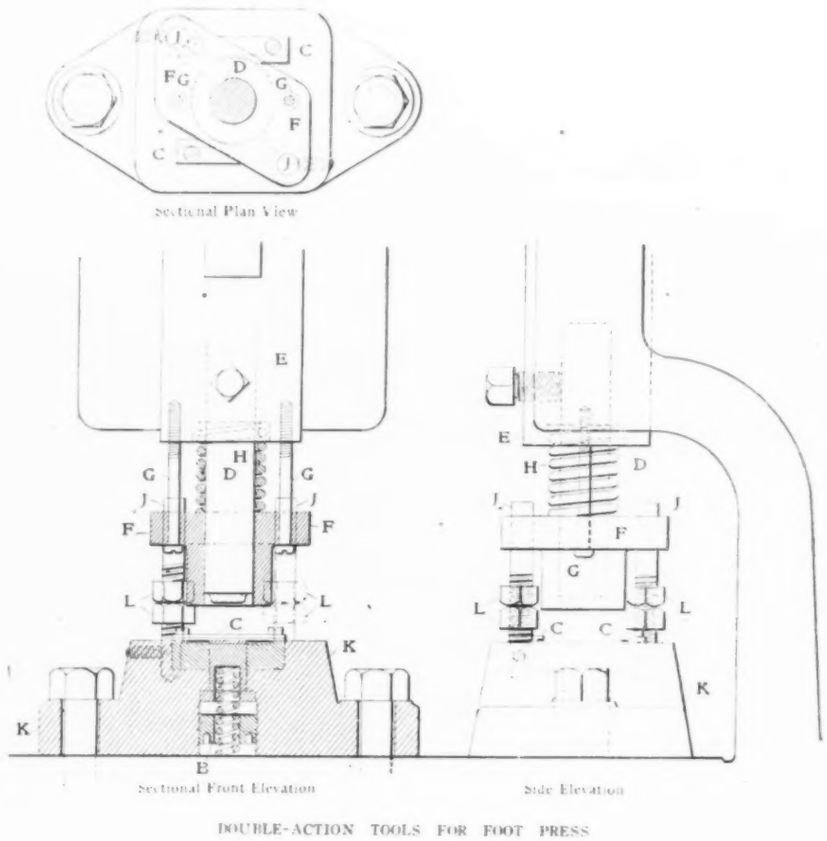
It will be noticed that the die is of the same type of construction as most dies used in double-action power presses. There is a spring-actuated knock-out *A*, which also serves for bottoming and setting the cup or shell when drawing it. This knock-out is pushed downward by the drawing punch until stopped by collar *B*, thereby affording a solid seat for setting the drawn cup or shell. Collar *B* is adjustable for different depths of cups or shells to be drawn. For strippers the usual method of combining stripper and gage for the stock is employed as seen at *C* in the three views.

The punches, both the cutting punch and the drawing punch *D* are operated with the ram *E*. The drawing punch is secured to the ram by means of a set-screw and will therefore travel the same amount as the ram *E*. Cutting punch *F* is suspended from the ram by two rods *G*, and is subjected to heavy pressure by spring *H*. In the case shown by the drawings it was necessary to counterbore into the ram in order to obtain the proper length for spring *H*. Cutting punch *F*, furthermore, is guided by two posts *J*, which are fastened into die disk *K* by set-screws and placed in such a way as to allow the stock to pass between them. When the punch *F* has cut the blank and carried it down into the recess in the die, prior to drawing the blank, the downward motion of the cutting punch is arrested by the blank resting on the die, but the ram and the drawing punch also continue their motion downward, the suspension rods *G* sliding through their holes in the flange of punch *F*. It is obvious that the pressure exerted on the blank will increase as the pressure of spring *H* becomes greater with the downward motion of the ram. In order to control the pressure to which it is desirable to subject the blank while it is drawn, check nuts *L* have been placed on the guide posts *J*. By means of these check nuts we can control the pressure on the blank and keep it uniform throughout the drawing operation.

The depth of draw which we give to a cup or shell depends on the length of stroke which is available after the blank is cut. By setting the cutting punch *F* higher or lower we can therefore control the depth of draw within the limit of the stroke of the foot press. This can be accomplished by adjusting suspension rods *G* as the occasion demands. These rods serve the double purpose of adjusting the cutting punch and bringing it back to its original position, when the ram travels upward. It should be stated here that there must be a liberal allowance for clearance between the stock and the bottom of the punches when they are up, as foot-press levers generally are not balanced so as to keep the punches in their highest position at the expiration of each stroke, the distance from punch to die varying from 1/8 to 1/4 inch after several successive strokes.

A foot press fitted up in this manner can take the place of a belt-driven double-action press in many cases. It will be observed that the operator may use the first part of the stroke for cutting, allow the cutting punch to rest on the blank for a longer or shorter interval and then continue the stroke, drawing the cup or shell. This is a valuable feature for drawing articles of paper or similar materials where it is necessary to allow impressions, indentations or crimping to set in the blank before drawing. On the other hand, the cutting and blanking operations may be finished in one rapid, continuous stroke.

The tools as illustrated here may be used with either hand or roll feed. In case a roll feed is used, it can be operated by the ram striking a lever when going upward. This lever in turn operates a ratchet which gives the intermittent rotary motion to the feed rolls.



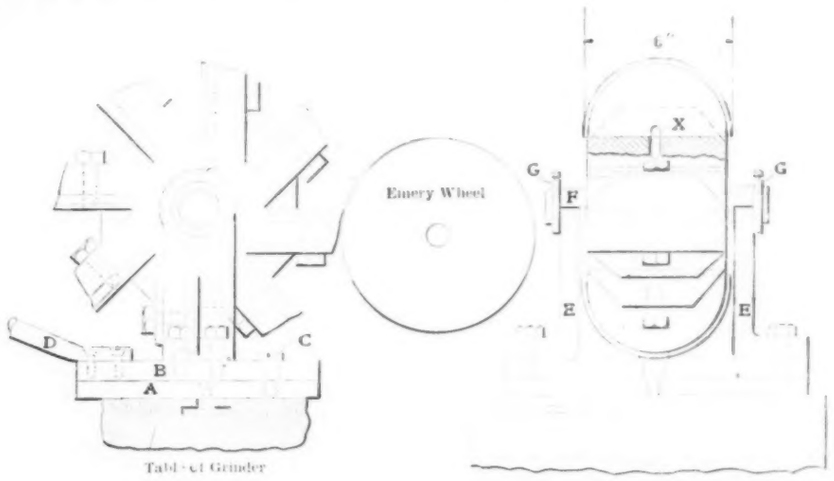
DOUBLE-ACTION TOOLS FOR FOOT PRESS

ED. E. EISENWINTER.

Providence, R. I.

A Large Radius Milling Cutter and Its Grinding Fixture

The accompanying cut shows a 3-inch radius milling cutter 12 inches in diameter which I designed some time ago to do a job on an Ingersoll milling machine and a fixture for grinding it. While the milling cutter may not be new, I think the fixture for grinding it will interest the readers of the AMERICAN MACHINIST.



A LARGE RADIUS MILLING CUTTER AND ITS GRINDING FIXTURE

The milling cutter consists of a soft-steel center or body bored to fit the arbor of the milling machine and turned 1/4 inch smaller in diameter than the blades, which are held in place by 1/2-inch hexagon head tap bolts and a slot in the center which is a fit over the pin *X*. The grinding fixture consists of a plate *A* fastened to the table of the grinding machine and plate *B* held in position by the pin *C* which is the center of the radius around which the cutter is swung by the handle *D*. The cutter is held in position on the half bearings *E E* and arbor *F* which is a driving fit. The collars *G* can be adjusted to bring the center of the cutter in line with the pin *C*.

The grinding can best be accomplished on a machine where the emery wheel can be raised or lowered so as to obtain the correct amount of clearance.

Bethlehem Penn. C. E. CHAMBERLAIN.

Wearing Qualities of Red Fiber

I recently had some experience which demonstrated the fact that commercial red fiber has remarkable wearing qualities. A piece of red fiber was used as a brake shoe, rubbing against a cast-iron wheel. The wheel resembled a worm wheel blank. The throat diameter was 25/8 inches, the outside diameter 27/8 inches and the radius of the groove 3/16 inch.

The fiber was shaped to fit the face of the wheel and subtended an angle of about 45 degrees. Instead of being a perfect fit, however, it was turned out to a slightly smaller radius than 1 5/16 inches, so that the ends only touched.

The shoe retarded the rotation of the wheel with a very light pressure; when the machine upon which the combination was used was brought to a stop the fiber was held against the wheel with a pressure of about 35 pounds. The wheel made about one-eighth of a turn after the full braking force was applied. It was started and stopped 1450 times a day for three months, or in all, 43,500 times.

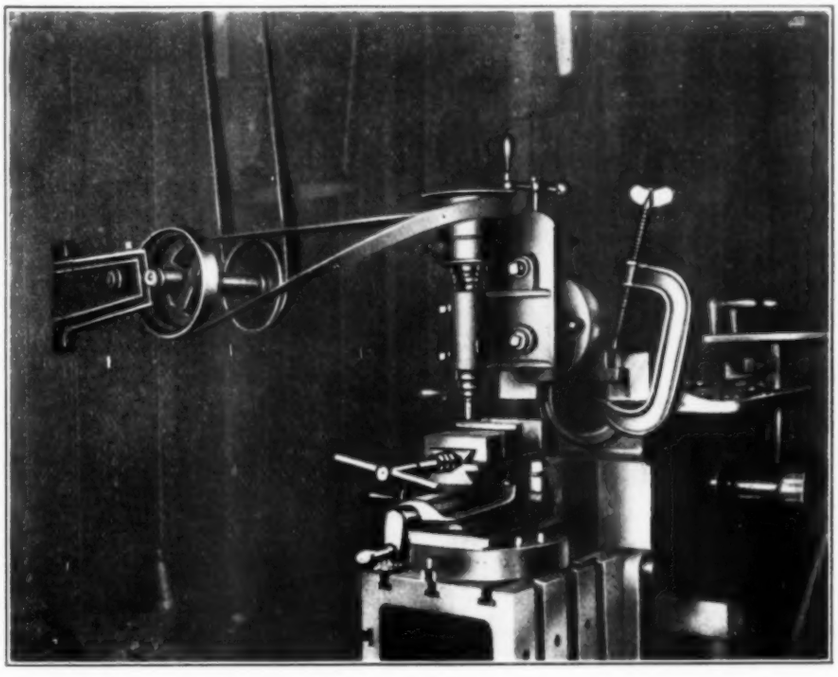
At the end of that time the shoe was removed. It was found that it hadn't even worn to a full seat. There were smooth spots at each end about 3/16 inch long. The wear at the highest point or ends was not over 1/100 inch. The area of the bright spots was 0.17 square inch, which brings the pressure per square inch up to 200 pounds. The combination was always slightly oily, although no attempt was made to keep the surfaces lubricated.

New York City. E. D. GAGNIER.

A Simple Milling Attachment

The accompanying picture shows a shaper from which the tool holder and block have been removed and in their place a bracket casting carrying a spindle, with fittings to withstand thrust in both directions, having at one end a three-step cone pulley and a properly tapered hole to receive bushings which carry the different cutters at the other.

The cut clearly illustrates how the ram is locked in position while the shaper is being used as a miller. The head can be swiveled to any angle not greater than 15 degrees in either direction and still be driven by the same belt; this is accomplished simply by letting the belt pass over the two large, middle, or small steps of each cone. In the picture it will be noticed that as the belt is a little loose it is working on the center cone on the countershaft and on the largest cone on the spindle. When gears are to be cut the vise is taken off and a special bed carrying a dividing head and dead center is bolted in place, and for spiral gears it is a "cinch" (as the boys say) to gear from the head to the cross-feed screw and feed by hand.



A SIMPLE MILLING ATTACHMENT FOR THE SHAPER

Naturally one will ask "What shop would bother with such a contrivance?" The answer is that when a shop has only one man working in it, and he is cramped for space, and only works nights and Sundays for pleasure and recreation, it will be seen that the outfit has its use.

Canada. W. L. McL.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

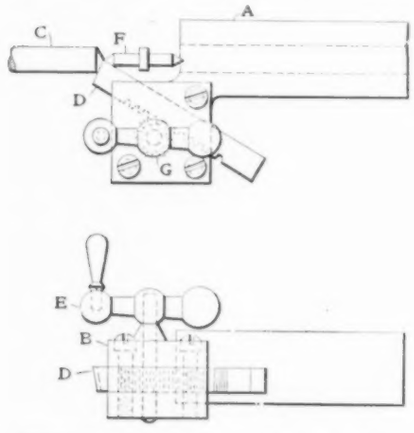
Cutting Threads from One Side

In Mr. Erb's article at page 663 on cutting internal threads with the compound rest he does not state which way he feeds the tool or on what side of the tool he does the cutting. I have found it to give better results when fed outwardly, that is, so that the cutting is done on the back edge of the tool instead of on the leading side of the V. This avoids chattering. I have tried feeding the other way so as to do the cutting with the front edge of the tool without success.

Chicago, Ill. C. G. KRANZ.

Cutting-off Tools for Screw Machines

I was interested in an article by J. G. Owen, on page 443, under the heading, "A Circular-forming Cutter Problem." I don't think the tool he shows is the proper one for cutting off a pinion staff to have ends 60 degrees and used as centers. It is bound to break off before it gets to the center, due to the large cutting surface the whole length of bevel and also leave a ridge. This, to be a good job, would require another operation.



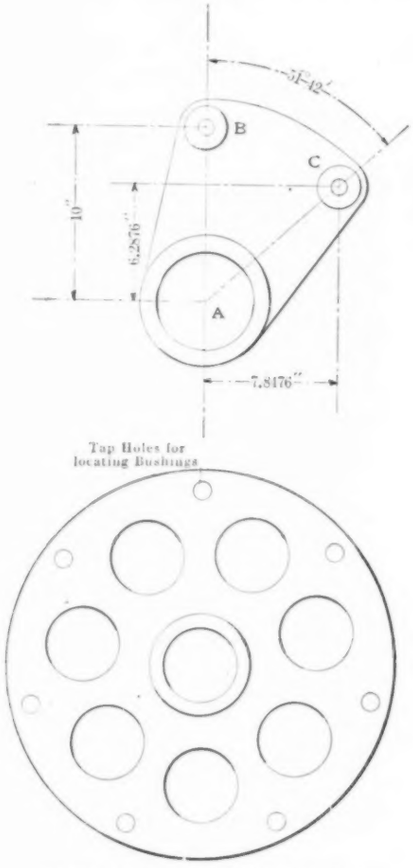
CUTTING-OFF TOOL FOR SCREW MACHINE

I would suggest that he try a tool similar to sketch. *A* is shank to hold in turret, *B* is steel cap held by three screws, *D* is the tool with teeth cut in it to operate in rack, *G* is pinion to operate in rack; *D* has top of tool on center. A groove is cut for tool *D* to slide in and at 30 degrees. *C* is to represent the stock and *F* the pinion staff to be cut off 60 degrees. The operator brings his turret to a stop and turns the handle *E*, thus feeding the tool in at 30 degrees with all the pressure on the stock. The staff will remain until tool reaches center, as there is no pressure on it. For use in automatics, Brown & Sharpe furnish a splendid tool that is operated by cross-slide, also made to swing tool for different angles.

Mt. Vernon, N. Y. McK.

Simple Jig for Locating Holes

The idea Mr. Richmond explained to the readers on page 354 is very good,



SIMPLE JIG FOR LOCATING BUSHING

providing the shop has the micrometers. With an accurately made jig as shown it is possible to set locating pins very quickly to within 0.0001 inch. Hole *A* in jig is bored to fit hub on piece to be machined, holes *B* and *C* are for placing locating pins.

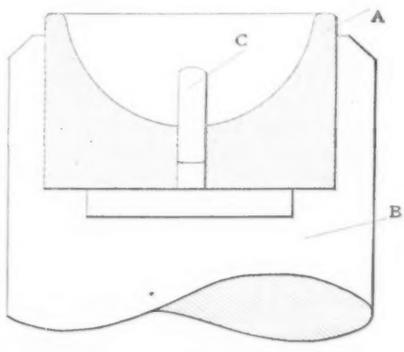
This jig can be used to drill tap holes for locating pins by simply making a bushing to either hole *B* or *C*, the hole in this bushing to be the size of the tap drill. Place jig on work, drill first hole and tap, place locating pin in hole just tapped, using jig to locate pin; jig is now firmly held in position for drilling and tapping second hole.

After drilling second hole remove drill bushing from jig and tap, place second locating pin; this fills the three holes in jig. Advance jig one pin and drill third hole and so on until all holes are drilled and pins located. This jig is simple and cheap to make. If properly made and care taken to bore holes to size given, the results will be satisfactory. The jig shown is for 7 holes in a 20-inch circle.

Philadelphia, Penn. C. H. ERB

Removing Stop Pins

The articles on pages 177 and 355 about removing broken stop pins, broken feet in drill jigs, etc., remind me of a similar trick which I used to remove a ball joint cup, but instead of using hydraulics I used steam power. Refering to the line cut, *A* is a hardened steel ball joint cup forced into *B*, a soft-steel cylinder. After some exhaustive experiments it was decided that the hardened-steel cup was not up to the requirements and a cup made from agate was decided upon to take its place. The soft-steel cylinder *B* was part of an expensive scientific instrument and as a matter of economy the steel cup *A*



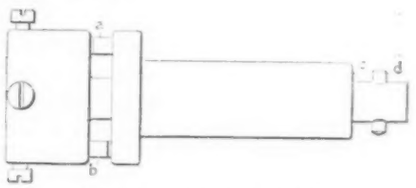
REMOVING A CUP BY STEAM POWER

had to be removed by some means. Fortunately the cup *A* had a hole drilled in its center and a cavity in the cylinder beneath the cup. I decided to fill the cavity and part of the hole with water and closed the hole in *A* by means of a copper pin *C* and put the whole thing in the blacksmith's fire. After a few moments the cup flew up, to the astonishment of some spectators.

Albany, N. Y. E. K. ROCHESTER.

Hardening Rubber Tools with Cyanide—A Tap and Die Holder

In a large electrical shop where I worked there were quite a lot of hard-rubber pieces to be made, and every mechanic who has ever worked this stuff in the lathe, miller, or other machine tool knows what a well developed faculty it has for taking the edge off the cutting tool. In this shop I learned the trick of using cyanide on the tools to make them hold their cutting edges longer. I worked



THE TAP AND DIE HOLDER

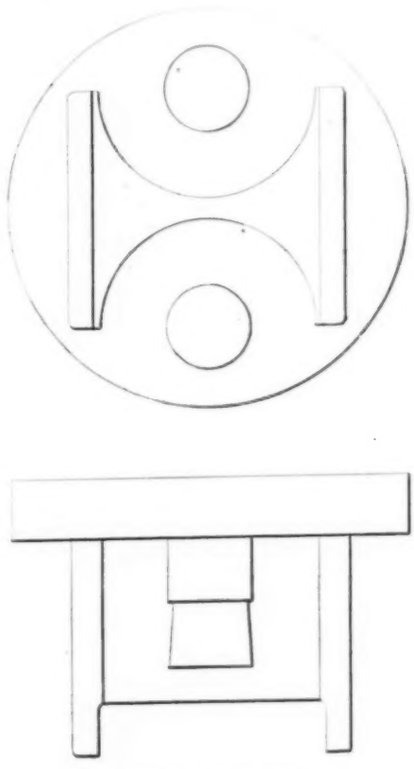
on a hand-screw machine, and the necessary tools for the job were obtained from the tool room, already tempered and ground, but if I had a job of hard rubber, I found it was to my advantage to harden the tools over again before starting on the work, using cyanide on them only to an extent equal to the depth of the cut, and not drawing the temper afterward. This I did with all the tools, both those for the turret and those for the cross-slide. On some hard-rubber jobs I have run the screw machine two days with one grinding of the tools, with the spindle running at its fastest speed, and this without burning the rubber, which almost invariably happens at fast speed when using tools hardened and tempered in the ordinary way. Of course, the cyanide has a tendency to make the tools brittle, and the feeding has to be done a little more carefully than on brass, for instance, but this is more than compensated for by the increased spindle speed and the extremely long intervals between grindings and consequent resettings. The object in view in this cyanide treatment was solely to add to the durability of the cutting edge, and thus increase the output per grinding. This stunt was not shown to me by the foreman, but by some of the other screw-machine operators, and did not seem to be generally known outside of a comparatively few men in that particular shop.

While on the subject of screw machines I would like to mention a style of tap and die holder that looks at first sight as though it would not back off the work. In the shop before referred to the holders were made something like the sketch, with the usual clutch pins *a* and *b* for driving and release, but the back end *c* of the outer sleeve, instead of being made cam shaped as usual, was turned perfectly plain and flat, the pin *d* only serving to prevent the parts from being separated and lost. The method of backing the die off the work was to hold the turret slide against its stop while the counter-shaft was reversed. For some unknown reason this caused the clutch pins *a* and *b* to again engage, and start the die off the work, after which the turret slide was allowed to gradually leave its stop. This device is not exactly orthodox, and has no business to work, but like the bug without the wings, it gets there just the same, and I have seen it used in other shops where I have worked. Can some one tell me why the clutch pins engage again after releasing?

Brooklyn, N. Y. GEORGE HARFMANN.

Lattice-bar Punch and Die

Referring to the lattice-bar punch and die, shown by T. Robson Charlton at page 401, I wish to state that I had the same trouble he mentions, some years ago, and I found that so long as the punch kept sharp, it would cut clear, but when the



LATTICE BAR PUNCH

cutting edge got dull, it no longer did its work of cutting but pressed the material off. This pressure tends to enlarge the circular end of the material between the piercing and separating punch, produces a wedging action and bursts the punch, when the piercing punch does not allow the material to move, especially in this case, where it is thick.

By Mr. Charlton's method the piercing punches enter the material before it is separated, which I think is dangerous. For, in starting the separating action the punch pushes the material from it, and the piercing punches are liable to bend or break, before entering the die. I suggest that the non-cutting sides of the separating punch enter the die before cutting. The separating should be done before piercing the holes, then by entering the die the punch will support the piercing members from bursting, and if the non-cutting sides of the separating punch are properly supported in the die, the punch will do its work to the last. To show the idea more fully a sketch of the punch is included.

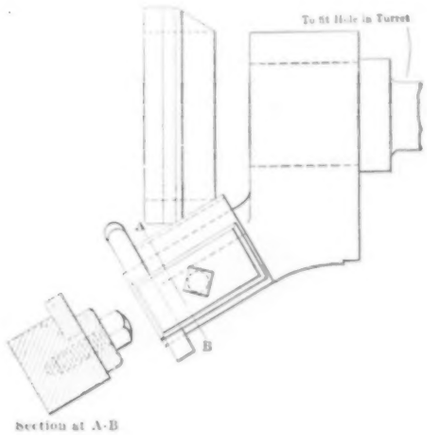
Edinburgh, Scotland. E. SHLAPS.

Making Metallic Packing

I note on page 466 a cut showing a tool for the turning or forming of metallic packing rings. This method of manufacture may be all right where the work is done by an expert machinist or toolmaker. If, however, the broad-cut tool referred to is not ground exactly correct, the result will be that the packing rings will not fit the vibrating cup properly.

The most up-to-date method recommended by one of the leading metallic-packing manufacturers is as follows:

Cast each ring separately. Rings then to be faced separately and finished in one operation with a tool as shown by accompanying sketch. The tools should be mounted in a toolholder fastened in the turret of the lathe, stops being provided to give the right diameter and length of



TOOL FOR TURNING METALLIC PACKING

bevel in order to save trouble of caliper-ing each ring.

It will be noted after the toolholder is once made the tools themselves may be cheaply produced. In grinding the tool for cutting the bevel all that is necessary is to grind the cutter parallel.

Chester, Pa. P. A. C. KING.

The largest aggregation of the most powerful steam engines in the world furnishes the power to operate the New York subways, the greatest work of its kind ever undertaken

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1907 *we printed and circulated* 1,151,500 *copies of the* AMERICAN MACHINIST.

Our circulation for May, 1908, *was (weekly, monthly and European)* 94,500.

June 4..... 35,250

This paper reaches 35,250 *separate readers each month and* 20,000 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

PAGE

Some Features of the Famous Creusot Works of France..... 857
Some Vicissitudes of the Job Shop—Wood Pulp..... 863
A Heavy Locomotive Wheel Lathe..... 864
Direction of Rotation and Thrust of Helical or Spiral Gears..... 866
Pneumatic Fixtures for Holding Work and Application of Compressed Air 867
Trade with Japan..... 868
Notes on the Design of a 36x36-inch Planer..... 873
Practical Letters From Our Readers: Double-action Tools for Foot Press....A Large Radius Milling Cutter and Its Grinding Fixture....Wearing Qualities of Red Fiber....A Simple Milling Attachment.....878-879
Discussion of the Previous Question: Cutting Threads from One Side....Cutting-off Tools for Screw Machines....Simple Jig for Locating Holes....Removing Stop Pins....Hardening Rubber Tools with Cyanide....A Tap and Die Holder....Lattice Bar Punch and Die....Making Metallic Packing.....880-881
Machine Shop Foreman..... 882
International Accident Congress..... 882
New Tools and Machine-shop Appliances 883

Machine-shop Foremen

A technical writer has recently declared, "The foremen of a machine shop are the most important men in it." While this is an exaggeration it is not so gross as to be offensive. With a little qualifying it states a broad truth. Numerically the workmen are, of course, the most important men in a manufacturing plant; as individuals the foremen are, perhaps, the most important.

We cannot conceive of a condition in which a machine shop could produce if for some cause it should be deprived suddenly of all its workmen, and should contain only a handful of executives and the machines. It would be a situation in which the all-important labor element of manufacturing was lacking. On the other hand, should a plant be deprived suddenly of all of its executives we can conceive of the workmen developing an organization of their own and carrying on production. This would be a condition in which both men and machines, two of the necessary elements of manufacturing, were present.

When we realize that the workmen are such an important element of production, and when we realize how important is the successful guidance of this element by the executive in order to get the best results in production, how important it is that the means which transmits the orders and desires of the executive to the workmen shall be of the highest quality! A carefully built and installed steam engine may be standing beside a splendidly equipped battery of boilers under full steam, but the engine cannot turn over to perform its work until the connection to the boilers is in perfect working order. The machine-shop foremen, who are the connecting links between the executive and the workmen, must be at their best if the entire organization is to produce effectively.

A management may be well disposed toward its employees; it may wish to pursue a liberal policy of treatment, but if its desires are not properly transmitted to the workmen they may get an entirely erroneous opinion of the management's attitude. The destinies of the individual workman are very largely in the hands of his foreman. Increases of pay, the selection of work, assigning of machines and the creating of conditions amidst which a workman must spend nearly one-third of his existence are, in the average shop, entirely in the control of a department foreman. Labor troubles can be quieted down or aggravated by his actions; the morale of the shop depends very largely upon the example which he sets; time and money are directly within his control. He may be careful of his machine tools or negligent of them. He may be efficient in his up-keep of small tools and thus materially increase the productive value of his department, or he may let such details run to loose ends and thereby reduce the efficiency. The environment of the individual workmen, the execution of the policies of the management, the control of the quantity and quality of production are more directly in his hands than in the hands of any other one man in the department organization. Should he not then be selected with the greatest care?

Too often he is a man who has grown up in the department in which he is promoted, and is one who knows very little of manufacturing conditions outside of what he has seen in his own shop. While such a man may be willing and efficient within the limits of his experience, it is evident that a man who has seen a large variety of work of the particular class which he is overseeing is better fitted for an executive position. Again, a foreman is sometimes selected because he is an excellent workman. It is a frequently noticed fact that the best workmen often make the poorest foremen. Executive ability, a quality that is largely inborn, must be in a man's make-up if he is to direct successfully the labors of others. Coupled with this there must be tact and experience.

Since they are such a vital part of the factory's personnel, department foremen, job foremen, working secondhands, gang bosses and, in fact, all of the executives who come in immediate contact with the workmen should be selected with the utmost care. After having been selected they should be instructed and trained and aided, in order to increase their own effectiveness and thereby aid directly in increasing the effectiveness of the whole factory organization.

International Accident Congress

Among the most important international congresses to be held this year in Europe is the eighth international congress for the prevention of accidents. Its sessions are held every three years, and are always attended by the most influential governmental officials, publicists, social economists, men of affairs, and others. The reports of the congress are made by the most eminent world specialists, so that the volume of these proceedings is the record of the world's latest and best advance in accident prevention.

Of especial value will be the report of an international commmittee on the standardization, so to speak, of accidents, their causes, duration, and results, so that a world standard may be agreed upon as the basis for a comparative study.

Membership in this congress is only $2, which entitles the subscriber to all the reports and the complete proceedings. The membership fee may be sent to Dr. W. H. Tolman, 231 West Thirty-ninth street, New York, by whom it will be acknowledged and forwarded to Rome.

New Tools and Machine Shop Appliances

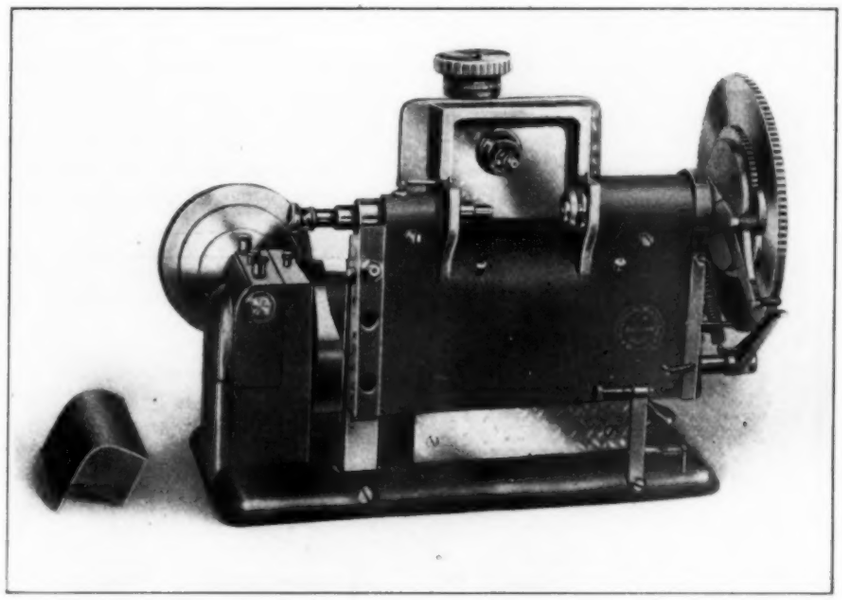
Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Small Automatic Gear Cutter

This machine has been designed for work up to 3 inches diameter and is particularly fitted for cutting thin brass gears in a stack. The index is 10 inches in diameter, so that extremely accurate divisions may be obtained on the work, and by means of change indexes a range from 12 to 240 divisions can be obtained. The cutter spindle is designed for high speeds, and the slide carrying the cutter is automatically lifted during the return of the work slide to give an opportunity of indexing during the return and so avoid loss of time. There is a quick-return stroke, so that the production is only limited by the durability of the cutter. Although weighing 250 pounds the base occupies but 190 square inches of bench space, yet all the adjustments are easily accessible. The depth of cut is obtained by a graduated handwheel, shown at the top. The index can be changed without removing any other part, and the indexing mechanism can be adjusted to the different divisions by means of a single screw. The worm and gear run in oil and are fully covered, but can be removed without disturbing the other parts of the machine.

Very complete protection from chips is provided in the following manner: A plate, scraped to a fit to the hood of the work slide, is fastened to the cutter slide, and it is sufficiently large to cover the opening in the hood when the slide is at its extreme positions and when the cutter is at its greatest hight. A detachable cover fitted to the front of the hood forces the chips to fall directly to the front of the machine where they do no harm and are readily removed.



SMALL AUTOMATIC GEAR CUTTER

Although the machine is designed especially for brass and similar material, it can be used equally well on iron or steel gears of fine pitch and by the substitution of a heavier spindle steel gears as coarse as 24 pitch can be easily cut. The complete chip protection is not so necessary, and for steel work it can be omitted and the capacity increased to 4 inches diameter.

An attachment can also be furnished for allowing the machine to cut twice around the work before stopping. This is also arranged so that the depth of cut is slightly increased for the second revolution of the work, and very smooth teeth are the result.

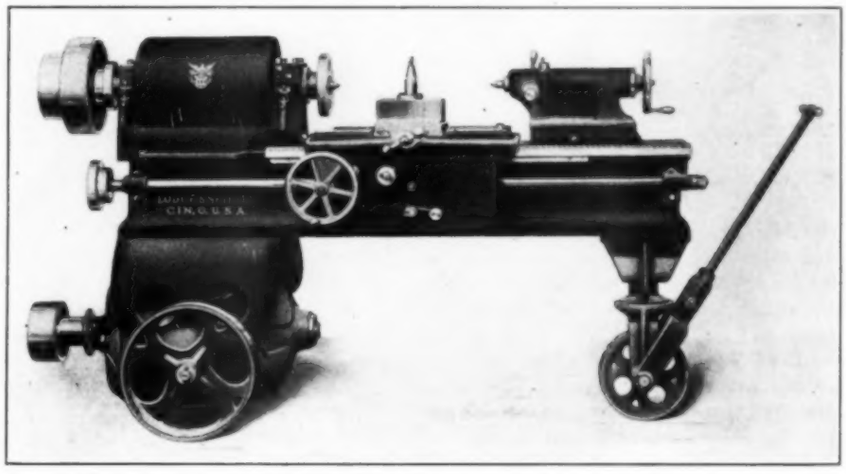
This machine is built and finished in the same style as that used by the makers, the Waltham Machine Works, Waltham, Mass., on their automatic watch and clock machinery.

Portable 16-inch Lathe

This lathe is intended for use in fitting frame bolts, turning up studs, and similar work in locomotive repair shops, and doing the various odd jobs which come up on the assembling floor of shops manufacturing a heavy class of machinery, where it has been necessary to carry the parts to be fitted to the lathe department.

The lathe bed is mounted upon three wheels and on a fairly level floor may be pulled about by one man. The motor, a 2½ horse-power constant speed, fully inclosed, is suspended under the headstock and belted to a two-step cone pulley mounted upon the back gear shaft.

As the range of work is narrow and for the sake of simplicity the speed changes are but two in number, avoiding



PORTABLE 16-INCH LATHE

the complication and expense of the geared head. The lathe has a belt feed of two changes, power longitudinal feed and plain rest. It can also be supplied with taper attachment.

It has been designed with the sole idea of doing this one class of work with the greatest rapidity. When desired it is furnished with legs instead of the wheels. It is manufactured by the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio.

The Akron Friction Clutch

The distinctive feature of this clutch is its roller toggle which gives an effective

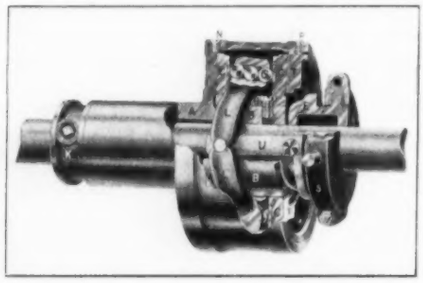


FIG. 1. SECTIONAL VIEW OF CLUTCH

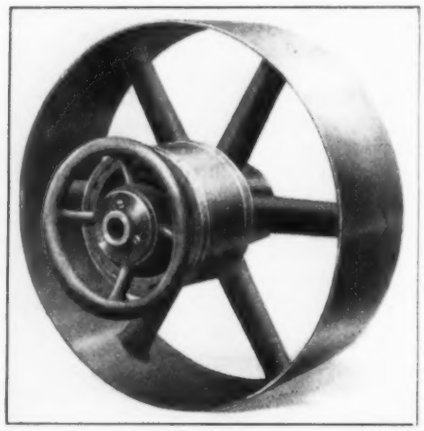


FIG. 2. AS APPLIED TO GAS-ENGINE PULLEY

clutching action with very little friction. The forked toggle levers *L* are slotted for the hardened and ground tool-steel rollers *G* which force the friction plates *C C* apart and into contact with drum *A* and its head *T* which is adjustable so as to secure any friction desired. This is so arranged that one notch of adjustment varies the two surfaces 1/120 of an inch.

The friction disks *C C* are fastened solidly to the shaft by keys *H*, and through sleeve *B*, and have hardened steel plates let into them to take the thrust and wear of the rollers. When the toggle forces the plates *C C* into contact with the clutch body they begin to revolve together. The toggle levers are operated from each side by the links *U* which are moved by spool *E* when yoke *S* is thrown in or out.

Every precaution is taken to make this a long-lived clutch, the drum *A* being filled with oil to lubricate all the moving parts and reduce wear as much as possible. In the same way the shifting yoke *S* is made to inclose the cone flange so as to retain oil and keep out the dirt.

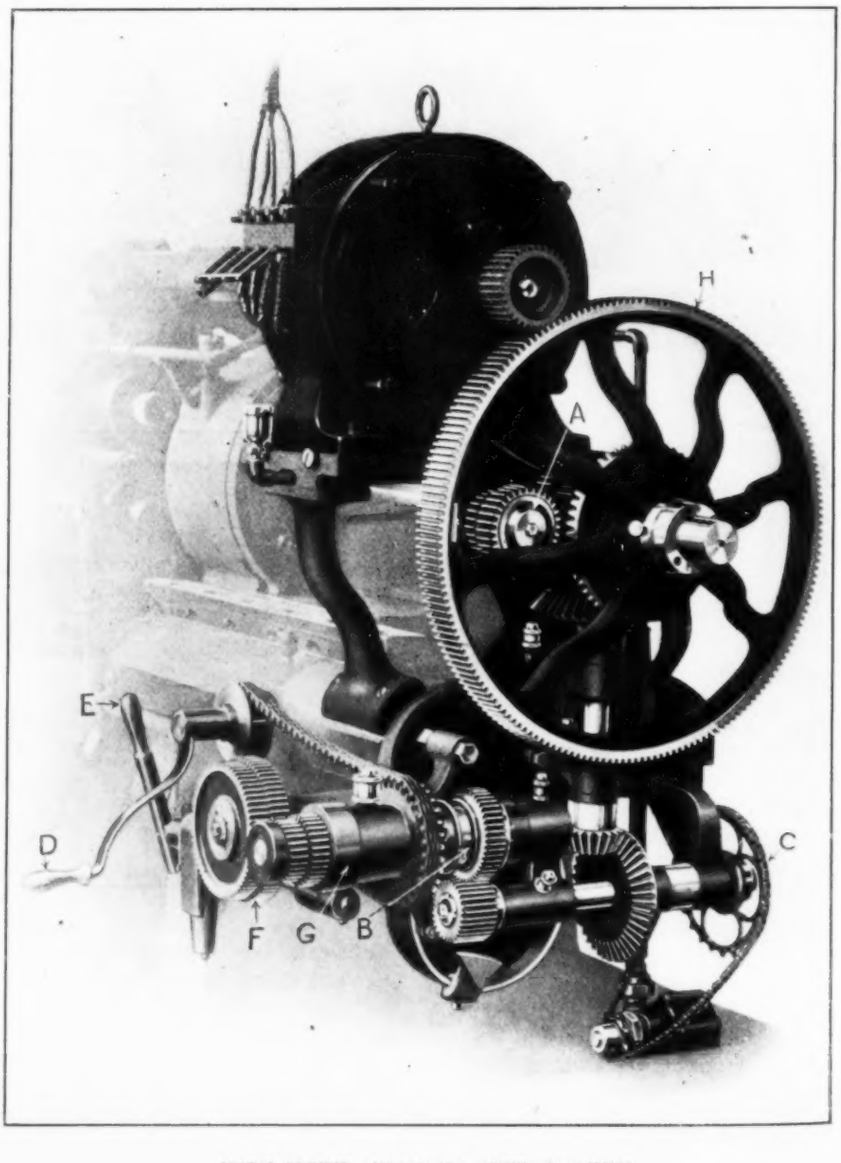
This clutch is easy to apply, the entire operating mechanism being handled as one piece. The pulley is not a part of the clutch and can be changed at will, or standard gears or sprockets mounted on the clutch sleeve if desired. It presents a round, smooth appearance, all operating mechanism being inclosed, which prevents men getting caught. The adjustable feature allows it to be set so as to lock solidly or to slip at a given point to act as a safety valve for preventing damage to other machinery. Fig. 2 shows its application to a gas engine.

Two of these clutches are in use on a special machine of the Union Spring Manufacturing Company, New Kensington, Penn., where they are thrown in and out 3000 times a day at 740 revolutions per minute and have had few adjustments and no repairs in nine months. They are made by the Williams Foundry and Machine Company, Akron, Ohio.

Motor-drive for Screw Machines

The National-Acme Manufacturing Company, Cleveland, O., has recently applied the single belt or gear drive to its multiple-spindle screw machines. In the illustration shown the belt has given way to the motor, but is the same in other respects. This has the advantage of making the relation between the cam-shaft and the spindle drive always positive, so as to cut out accidents to tools due to belt slipping. It also avoids belting troubles, allows the countershaft to be either greatly simplified or eliminated, and it allows positive control of the change of speed at all times.

Referring to the illustration, *A* shows back gears for spindle driving shaft; *B*, clutch for change of speed; *C*, chain driv-

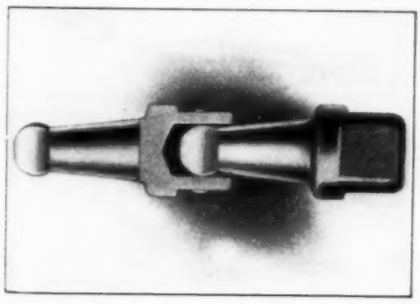


MOTOR-DRIVEN AUTOMATIC SCREW MACHINE

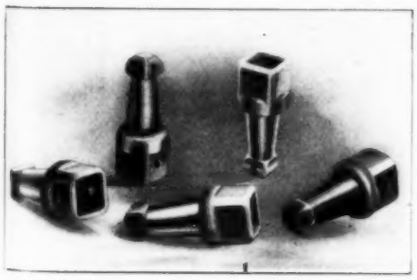
ing the pump; *D*, crank for allowing operation by hand; *E*, hand lever controlling clutch *B*; *F*, change gears; *G*, free or idle wheel; *H*, gear substituted for pulley on main driving shaft. The lever *E* gives complete control in case of accident and in setting up or testing the machine. Operating by hand is made easier, as the transmission mechanism is entirely cut out by means of the free wheel *G*. The more convenient location of the change gear *F* reduces the time necessary for changing the speed of cam-shafts. The control of hand and power movements of the cam-shaft mechanism, as well as flow of oil to the tool are all within the reach of the operator, while he is standing in a position to observe the action of the tool. Any standard motor either alternating or direct current can be used without alteration, from 3 to 5 horse-power being required according to the class of work for which the machine is used.

A New Flexible Shaft

When the Coates Clipper Manufacturing Company, Worcester, Mass., began making flexible shafts 20 years ago, each unit had 12 parts, and was quite hard to manufacture. Since then they have made several designs, each one more simple than the other, and they seem to have



SECTION OF FLEXIBLE SHAFT



FLEXIBLE SHAFT UNITS

struck bed-rock in the shaft, shown herewith, as each unit has one part, if we omit the pin which is soft and simply keeps the units from falling apart, but takes absolutely no driving strain.

One end is a squared spheroid which goes into the squared socket in the other end of the next unit, driving it freely even at quite an angle. Outside the socket is a cylindrical ring, or shoulder, to form a bearing in the outside cover, which will run freely and present a smooth wearing surface. Each unit is made of steel and hardened and is so strong that it can be run at a slow speed and still give all the power needed. They are being made in sizes from 1/10 to 5 horse-power.

A New Arc Lamp

The importance of proper shop lighting makes it necessary for all shop managers

NEW FLAMING ARC LAMP

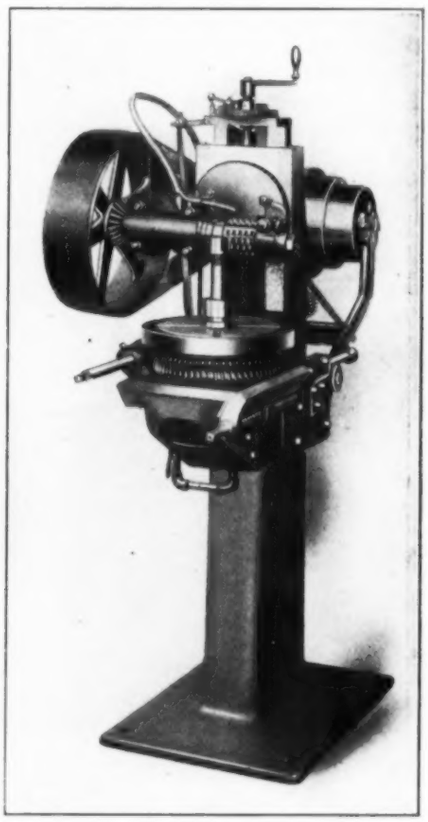
to keep in touch with the development of this field, and we show herewith a new flaming arc lamp, which has recently been placed on the market by the General Electric Company. The mechanism of these lamps is extremely simple, as there is no chain feed or complicated escapement with clockwork of any kind. It is of the inclined carbon type, and has nothing below the arc to obstruct the light. Both carbons feed by gravity, and the regulation of the arc is acomplished by the lateral movement of one carbon in relation to the other.

There is an economizer of refractory material surrounding the points of the carbon just above the arc, which steadies the arc from the effect of air current to a considerable extent. There is also a heavy baffle plate above the economizer to prevent any appreciable amount of the product of combustion from the arc being deposited on the part of the mechanism above. This baffle plate becomes coated with a white deposit from the arc and acts as an excellent reflector which throws the light downward.

These lamps are designed to burn singly or two in series on 100- to 125-volt direct- or alternating-current circuit, and can be used on any frequency between 40 and 140 cycles. The lamps are wound for either 8, 10, or 12 amperes, and are equipped with light opal globes. The life of the carbons is about 12 hours on indoor circuit and between 10 and 11 hours used out-of-doors.

New Gear-hobbing Machine

One of the noticeable features of this gear-hobbing machine is the driving of the hobbing spindle so as to allow the hob to be inclined to any angle used in this work without the necessity for a train of bevel gears as is usually done.



NEW GEAR-HOBBING MACHINE

The main drive of this machine is by a 2½-inch belt on the three-stepped cone at the back which gives three speeds for the hob. This shaft is belted to the hob spindle by a 4-inch belt, the large pulley being 15 inches in diameter, so as to secure the proper speed and a good belt contact.

The hobs regularly used are right-hand, single-thread, 3 inches in diameter and 3 inches long, with a 1¼-inch hole and provided with a ¼-inch keyway, although

other sizes can be used if desired. The table carrying the work is supported on a substantial knee and revolves with the work while the hobbing cutter is being fed down across the face of the gear. A small plunger pump forces a stream of lubricant on the cutter and on the work when desired. The knee supporting the table is made hollow so as to form a reservoir for the lubricant, and holes through the table allow this to run from the work to the reservoir beneath.

The feeds are taken from the bevel gear inside the spindle pulley. The vertical feed is by means of a pawl and ratchet operated through a reducing gear by an eccentric on the worm shaft. This is controlled by the button on the bell crank at the top of the machine and can be changed without stopping it. A trip automatically stops this feed when the hob has finished the gear. No attention is required by the operator other than putting on blanks and taking off finished gears.

A rigid stop is provided, against which the table saddle may be run, to give the proper depth of the teeth. Instead of setting this stop by micrometer graduations which require much care in setting, a hardened-steel gage is provided which is of a thickness equal to the depth of the teeth of the pitch desired. To set the stop, the table is advanced until the blank contacts the hob. The stop is then screwed up against the gage block. When the gage block is removed and the table is advanced to the stop, the correct depth is obtained. After the stop is set for a given diameter any number of gears of same size are cut the proper depth by simply moving table to this rigid stop.

All bearing surfaces are large in proportion to the work they perform so as to insure durability as well as accuracy while in operation. It will cut gears up to 12 inches in diameter by 6-inch face. It is built by the Adams Company, Dubuque, Iowa.

Four-spindle Locomotive Frame Drill

The growth of the sizes of locomotives has made necessary a corresponding increase in the size and capacity of machine tools for building them and the drill press shown herewith has been designed for the heaviest frames that are likely to be used for some time to come. The length of the cross rail is 36 feet 8 inches with the table a trifle shorter and 25 inches wide. Each head is entirely independent, being driven by a 6 horse-power variable speed motor and can be moved to any position on the rail not occupied by another head.

They can be brought together so that the centers of the drill spindles are only 28 inches apart while the greatest distance between the end spindles is 34 feet 8 inches. Each has a vertical traverse of 20 inches and the three regular heads have an in-and-out movement of the same amount. The spindle can be brought within 16 inches of the top of the table and in its extreme position is 36 inches from it.

The heads are traversed by power from the two horse-power motor at the end of the rail which operate the long screw shown supported by rollers at frequent intervals. The heads can also be traversed by hand by the use of a ratchet wrench on the square end of the shaft shown at the end of the arm. This operates a pinion meshing in the rack on the rail which can be plainly seen in the details. The power traverse for the heads is controlled by the small lever in front of the screw which controls a clutch meshing into the worm gear plainly shown on the swivel head.

All feeds and speeds are under control of the operator from his position on the long platform which is always built in front of one of these drills, and these give him a range of from 50 to 120 revolutions per minute with the back gear and from 100 to 300 without back gears. The feeds per revolution are 0.01555, 0.01 and 0.0053 inch per revolution. Power feeds are obtained from the small cone of gears on the outside of the head and the hand feed is by the usual worm and wheel shown. The lever above the pilot wheel throws the

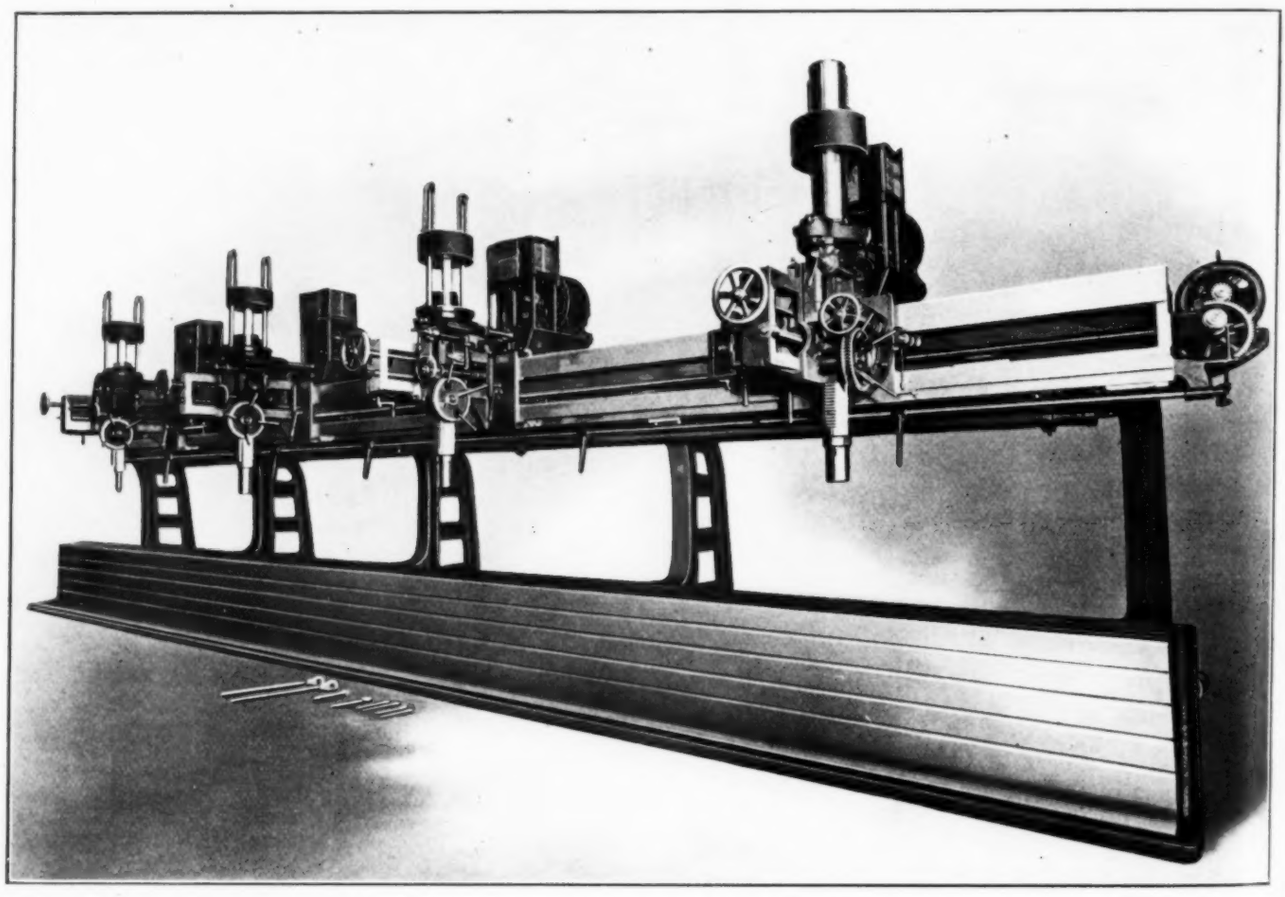


FIG. 1. FOUR-SPINDLE LOCOMOTIVE FRAME DRILL

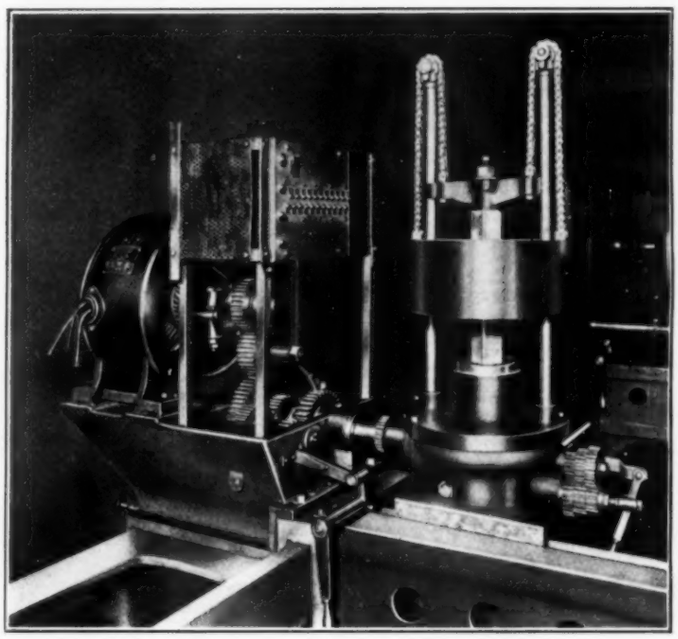


FIG. 2. THE DRIVING MECHANISM

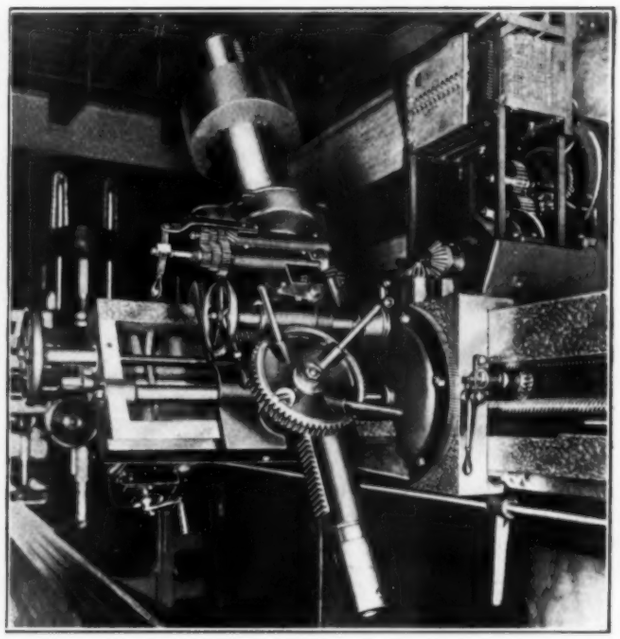


FIG. 3. THE SWIVEL HEAD

worm in or out of mesh as is desired.

The swiveling head is necessarily arranged somewhat differently from the others as all its drives must come from a central point around which it swivels. This necessitates the bevel gears shown and also the different arrangement for power traverse in this case. This traverse can be controlled from any point along the rail by any one of the five handles projecting downward from the rod below the rail and then each head can be thrown in independently as desired. It is also necessary to arrange the counterweights differently on this head and to use the sleeve for it to slide on instead of depending on the rods, which, while large enough when used in a vertical position, would bend if inclined as shown.

It will also be noted that the controller for each motor is at the outer end of the arm so as to be convenient, and also that there is a large pipe extending the whole length under the cross rail which acts as an oil or soda-water reservoir, and allows the use of a short hose at any point. This is much more convenient than running a number of small pipes or hose along the machine so as to supply the drills in any position. In this connection the oil channel provided at the foot of the base on all sides prevents the lubri-

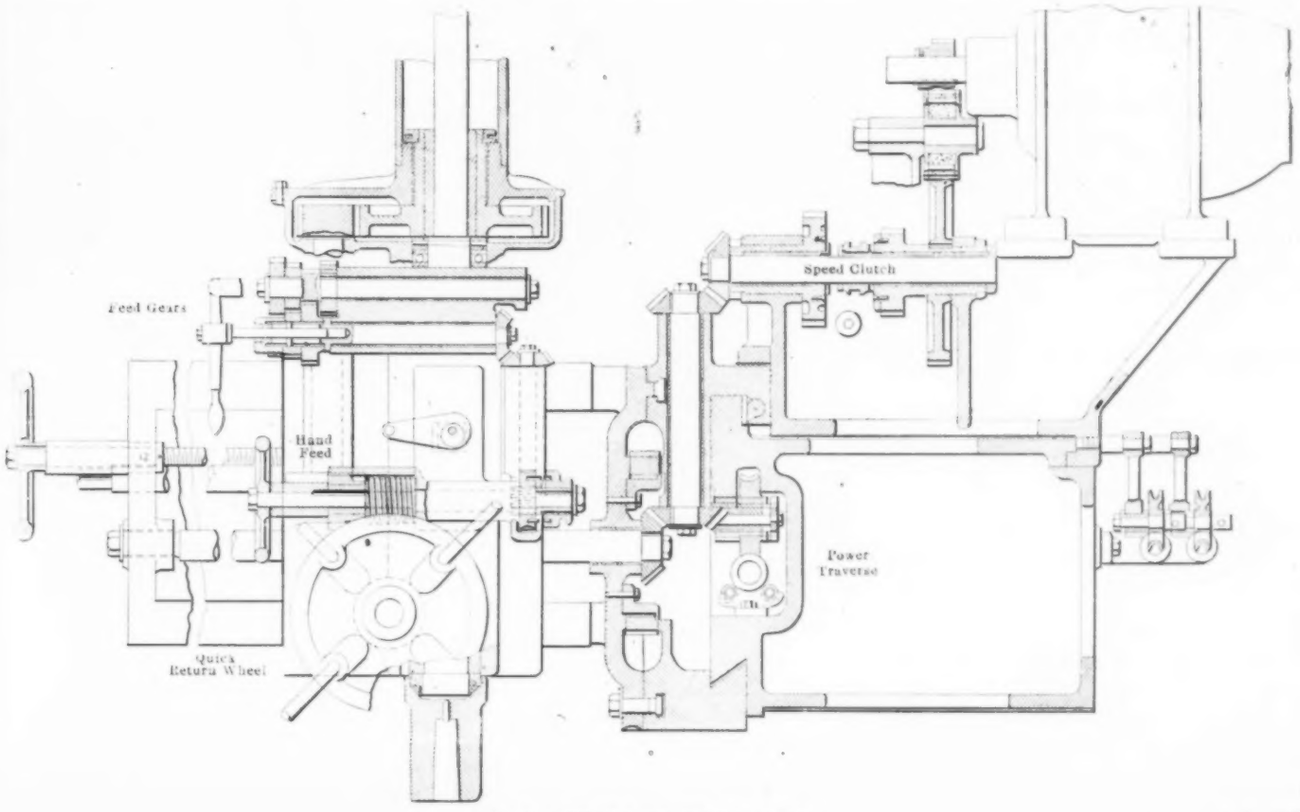


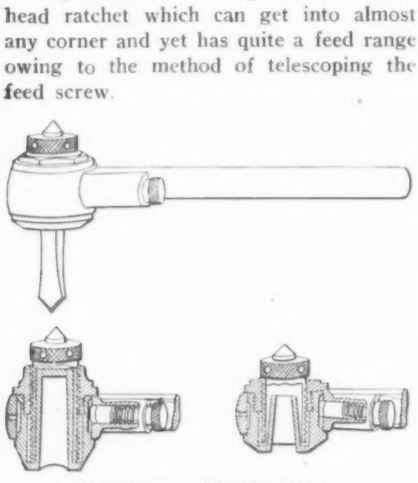
FIG. 4. DETAILS OF SWIVEL HEAD

cants running over the floor as would otherwise be the case.

This machine has a capacity of drilling four 2¼-inch holes in steel at the same time, occupies a floor space of 38 feet 8 inches by 7 feet 8 inches and stands 11 feet 7½ inches high. It weighs 46,600 pounds divided as follows: Table 14,550 pounds, cross-rails 11,075 pounds, housing 1117 pounds each, regular heads, 3225 pounds and the swivel head 3914 pounds. It was built by Edwin Harrington & Sons Company, Philadelphia, Penn., for The American Locomotive Works.

Short-head Ratchet Drill

There are many places where it is necessary to drill holes and the space is too small to allow a regular ratchet drill to go in. To meet such requirements the Armstrong Brothers Tool Company, Chicago, Ill., have brought out a short-head ratchet which can get into almost any corner and yet has quite a feed range owing to the method of telescoping the feed screw.



SHORT-HEAD RATCHET DRILL

The illustration shows two sizes of heads which are supplied with a 12-inch handle. The head at the left is 3¾ inches long and has a 2¾-inch feed while the short head is only 2¾ inches long and a feed of 1½ inches.

Manganese Steel Disks for Lifting Magnets

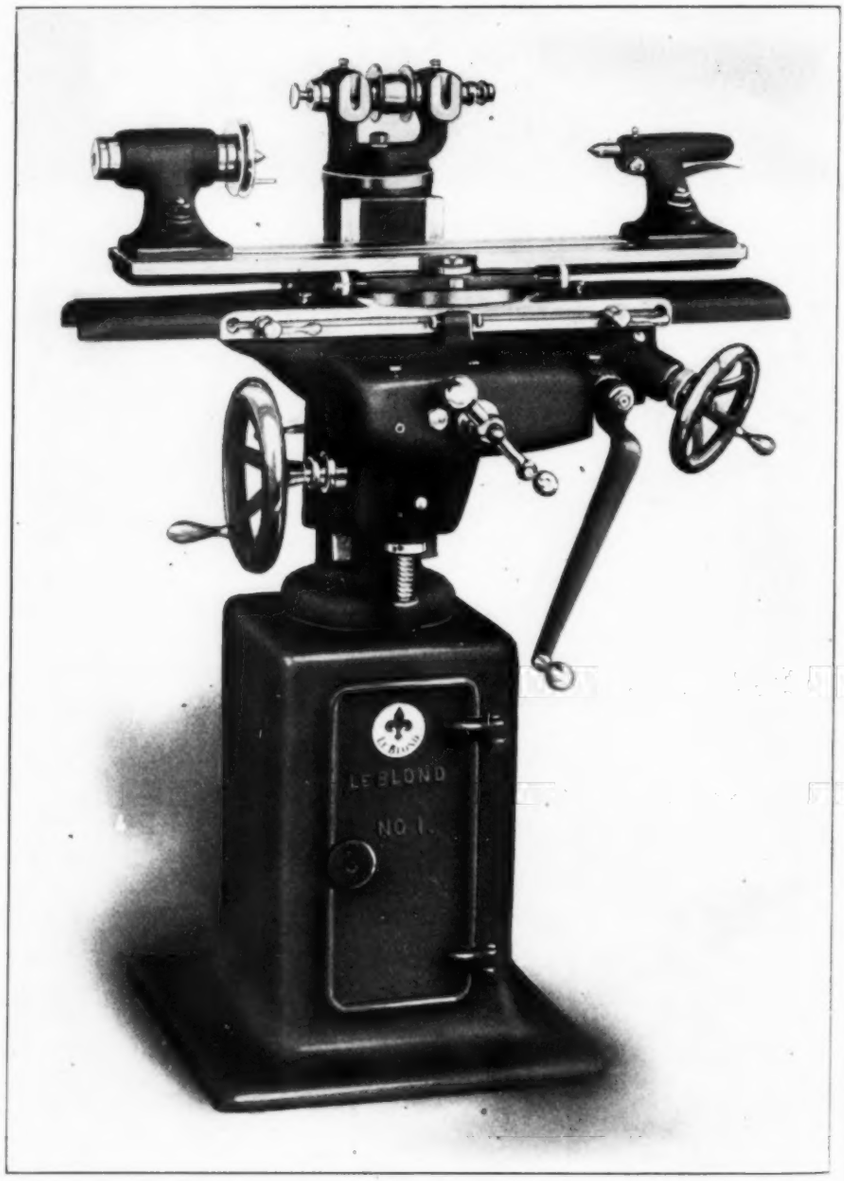
The Cutler-Hammer Clutch Company, of Milwaukee, Wis., has adopted manganese steel for its coil shields in place of the brass formerly used. These coil shields are the flat disks which are fastened to the under side of the lifting magnets for the double purpose of protecting the magnetic coil and interposing between the two poles of the magnet an area of non-magnetic material.

Ordinary steel will not do for this purpose because it is a magnetic metal and would serve to conduct the magnetic lines of force from pole to pole instead of compelling them to seek a passage through the metal to be lifted. A steel high in manganese, however, is non-magnetic and conducts this force through the metal to be lifted. Being very hard it does not indent by the continual hammering of the pig iron and other metals suddenly drawn toward it and having great toughness it does not break. This makes a disk that lasts practically as long as the magnet and does not wear to a rough surface.

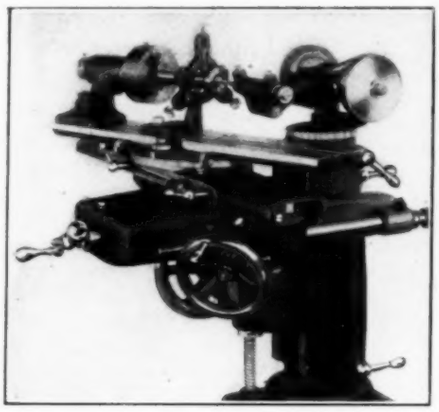
Universal Tool-room Grinder

This machine is entirely universal and especially adapted for tool-room work, as it will grind any part of any shaped cutter; grind any angle, taper or face, grind all kinds of cylindrical work, both inside and out, as well as doing any flat grinding within its capacity. It is designed somewhat on the lines of the milling machine, having a very substantial knee, which is mounted on a hollow column, which in turn swings around the base of the machine so as to bring the work at any desired angle with the grinding wheel. Graduations at the top of the column give direct reading as to the angle of the table with that of the grinding spindle.

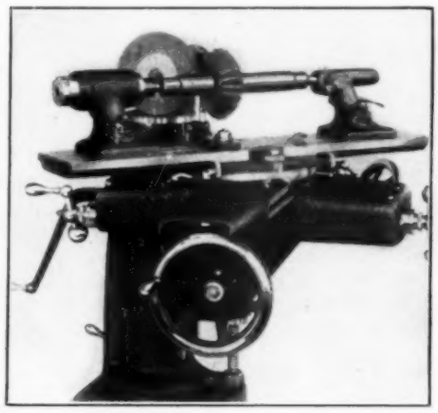
The arrangement of handles for operating are somewhat novel, being designed to be as convenient as possible for the operator in any position he may assume that will enable him to carefully observe the work being ground. The cross-feed and quick-traverse handles for the table extend through the machine and have a crank at each end, which is often exceedingly convenient. All adjustments are provided with a fine feed through hand-wheel at the front of the machine, and clamping handles are provided so as to make wrenches unnecessary. The illustrations show a few of the many opera-



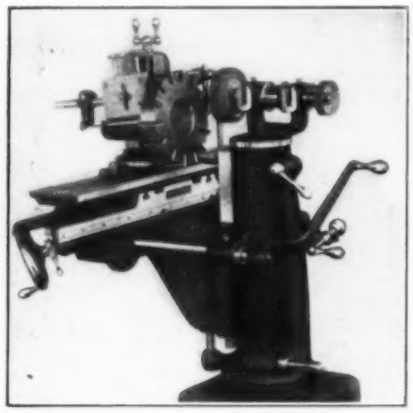
LE BLOND UNIVERSAL GRINDER



EXAMPLE OF INTERNAL GRINDING TAPER HOLE IN SPINDLE



GRINDING 45-DEGREE ANGLE CUTTER WITH FINE ADJUSTMENT OF TABLE



GRINDING FACE OF INSERTED-TOOTH MILLING CUTTER

tions which can be performed on this machine and include the use of the internal-grinding attachment, as well as of the universal head, which is being used to hold the large inserted-tooth milling cutter.

Care and attention have been given to the lubrication of all bearings which are oiled through and protected by felt pads. The spindle bearings have dust-proof collars. The saddle and table bearings are provided with covers and are never exposed. The knee bearing on the column has felt wipers.

The wheel spindle has taper boxes and is driven by a single pulley for 2-inch belt. Three spindle speeds, 3175, 4200 and 6365 revolutions per minute are obtained with the countershaft, permitting the correct surface speed for various size wheels. One end is bored for a Le Blond collet, and enables wheels to be removed and replaced without the necessity of truing up. The spindle is eccentric with the column and with the cross-movement so that the minimum and maximum diameters of cutters that can be taken in, is greatly increased.

The saddle apron is cast completely around the knee and forms a cover for it as well as for the cross-feed screw at all times; it has a cross-movement of 6¼ inches.

The table swivels through an arc of 90 on either side of the center and has a fine screw adjustment throughout this range for accurately setting to any taper. The base is graduated and is held rigidly in any position with two clamping bolts. It has a longitudinal movement of 17 inches. A quick traverse through a lever and rack is provided, and a fine feed for circular and internal grinder with a hand-wheel.

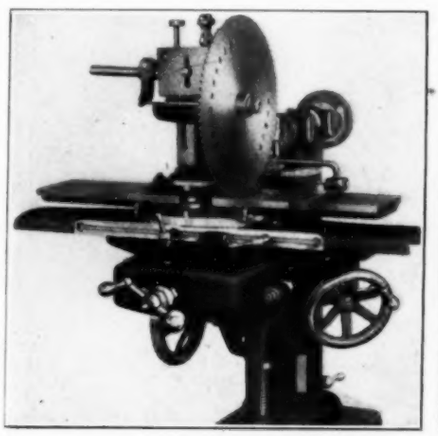
The head attachment is completely universal in all its movements. It swivels upon the base and the V-block can be swiveled completely around through a vertical plane. It will hold work mounted directly upon arbors, straight or taper shanks. The headstock sleeve and spindle can be clamped in the V-block and can be used for grinding work held in the chuck, such as cones, cups, collars, etc., the work being clamped by an adjustable jaw. Two thumb-screws one at each end of the jaw admit of delicate adjustment to the proper position. The floating center attached to an adjustable bar can be set for any length and diameter of work.

Headstock and footstock centers swing 8 inches and take 18 inches between centers. The headstock spindle, which is tapering, revolves in a removable sleeve, which can be clamped in the V-block of the universal attachment. The front end is threaded to receive the chuck. The footstock has a spring center actuated by a thumb lever. This center can be removed and a special center for grinding reamers inserted. A complete set of stop and tooth rests and fixtures go with the machine.

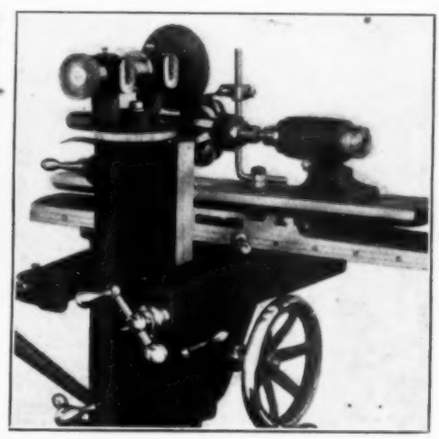
These machines have been tried out for over two years in the shops of the builders, the R. K. Le Blond Machine Tool Company, Cincinnati, Ohio.

Steam-driven Separator for Cleaning Chips

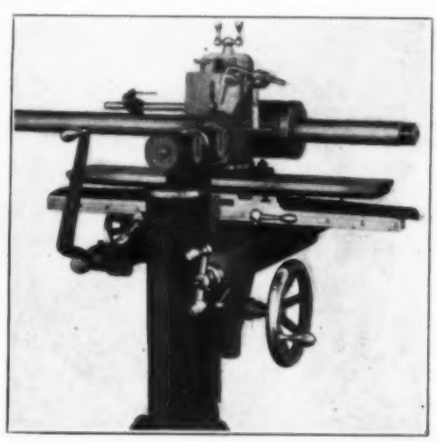
Any shop using oil as a cutting lubricant in any quantity realizes the necessity of reclaiming the oil, and of cleaning the chips. To meet the need of large shops, this machine has been designed, with a basket capacity of 3½ cubic feet, or very nearly 3 bushels of chips. The machine is self contained in every way, and all the manual labor necessary is for the operator to shovel the chips into the basket, or they can be conducted to it by an overhead chute, if more convenient. After the basket has been filled, it is swung around over the machine, the hoist is lowered and uncoupled, the covers



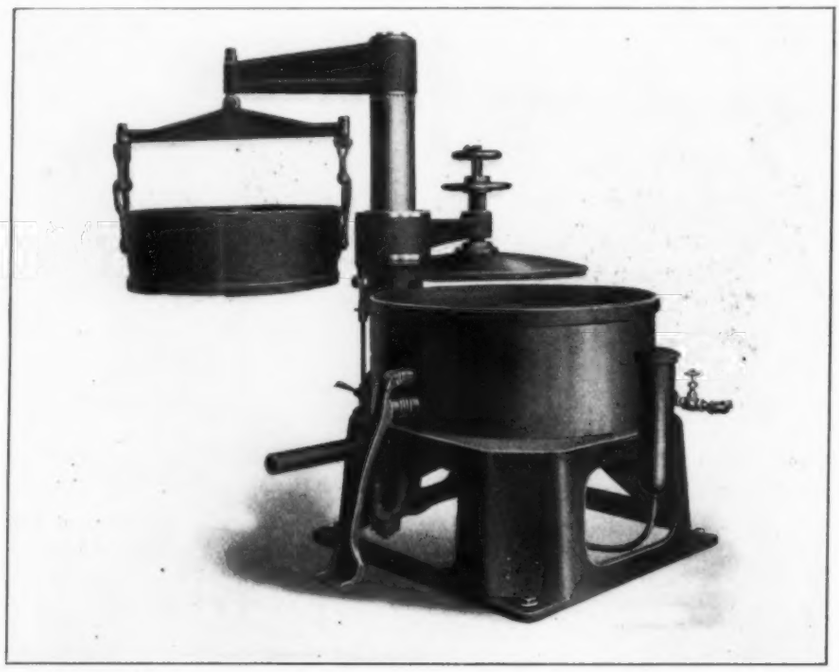
SHARPENING A LARGE 16-INCH CUT-OFF SAW



GRINDING FACE OF A FORMED CUTTER



SHARPENING 5½-INCH STEM REAMER WITHOUT REMOVING IT FROM STEM



WASTE CLEANING MACHINE

screwed down in position, and the steam turned on at the small valve on the right. This admits steam to the turbine, which is a part of the machine and is contained in its base, and this revolves the basket, throwing the oil out by centrifugal force. The exhaust steam from the turbine is utilized to liberate the oil from the chips and turnings. This aids to such an extent that the chips are left perfectly dry after the machine has been run six or eight minutes. Then the cover is unfastened, the crane yoke swung around to engage with the basket, which has been brought to rest by a foot brake. By pressing the small handle at the left of the machine steam is admitted to the cylinder, operating the crane hoist and is automatically cut off when the piston reaches a sufficient hight to enable the basket to clear the machine. At the same time steam is cut off, an automatic stop engages with the piston, holding it in position until the basket is again ready to be lowered into the machine. The pipe at the left under the basket is an oil discharge, so that it is very easy to catch this in receptable of any kind that may be most convenient.

The operation of loading and unloading, exclusive of filling the basket, requires but two or three minutes and is very easy to handle, as the arm carrying the basket and the cover are arranged with ball and roller bearings to reduce friction. Owing to its large capacity, it reduces the operator's expense to a minimum, and being independently driven, it eliminates belt trouble and can be located at any point, regardless of line shafting, as all it needs is a steam pipe.

This machine is made by the Oil and Waste Saving Machine Company, Philadelphia, Penn.

Combined Drill and Cutter Grinder

An attachment is being made for the well known Yankee drill grinder to enable cutters to be ground on the same machine and at the same time if desired. Attached to the side of the column is a table which carries an auxiliary grinding head and the fixtures for holding the reamers or cutters to be ground as shown in Fig. 1. This brings the work down where the operator can see it easily. The general design of these fixtures can also be seen in this view, the carriage for the work having a compound movement and allowing the reamers to be set at any desired hight.

Fig. 2 shows a better view of the graduated head by which any angle can be measured, being used in this case for backing off an angle cutter. Another setting is seen in Fig. 3 where a large inserted tooth mill is being given side clearance, the tooth stop and the method of supporting the cutter being plainly shown.

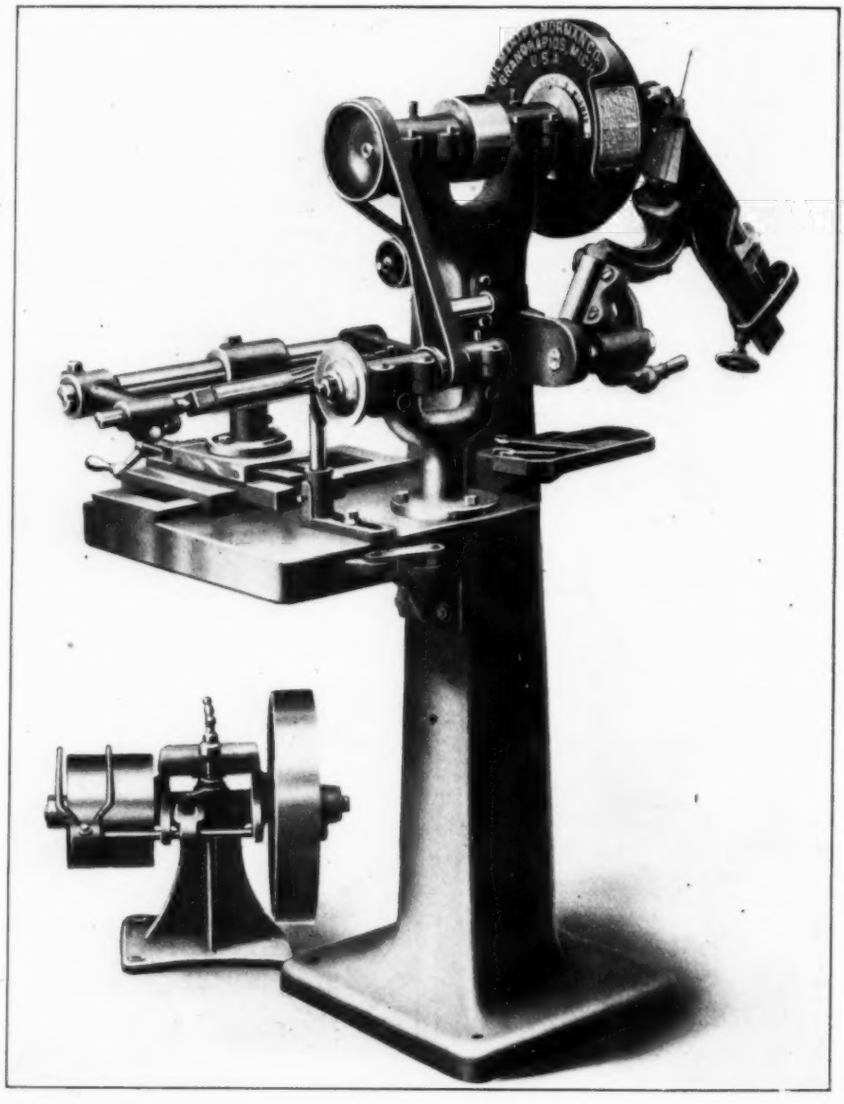


FIG. 1. COMBINED DRILL AND CUTTER GRINDER

Fig. 4 is the fixture for grinding gear and other radial tooth cutters. This has a universal adjustment which allows any movement. First the sliding table is set so a radial line from the center of the cutter strikes the grinding edge of the saucer-shaped wheel and the slide fastened by the thumbscrew. Then the hight is adjusted with a micrometer screw provided and the gage set to what corresponds with the grinding edge of the wheel. This gage stops the face of the

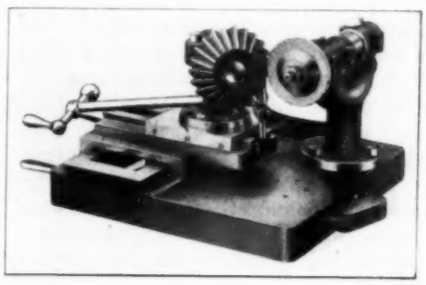


FIG. 2. PACKING OFF AN ANGLE CUTTER

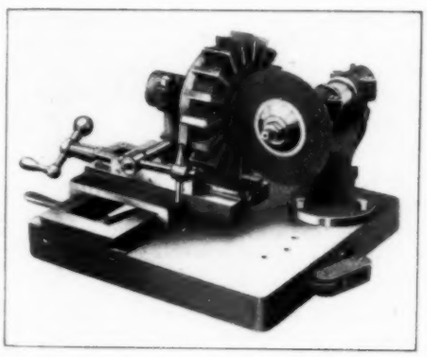


FIG. 3. SHARPENING A MILL WITH TEETH CAST IN

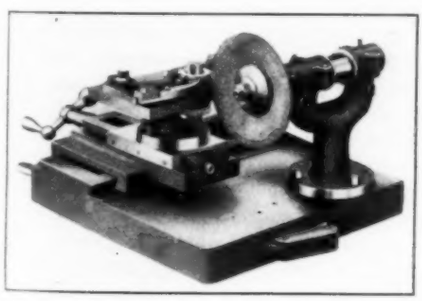


FIG. 4. GRINDING GEAR CUTTERS

tooth and the spring index dog keeps it in place until it is ground as desired.

This cutter grinder handles straight or taper reamers up to 8 inches long or 8 inches in diameter and any cutter or reamer within these limits can be easily ground. It is made by the Wilmarth & Morman Company, Grand Rapids, Mich.

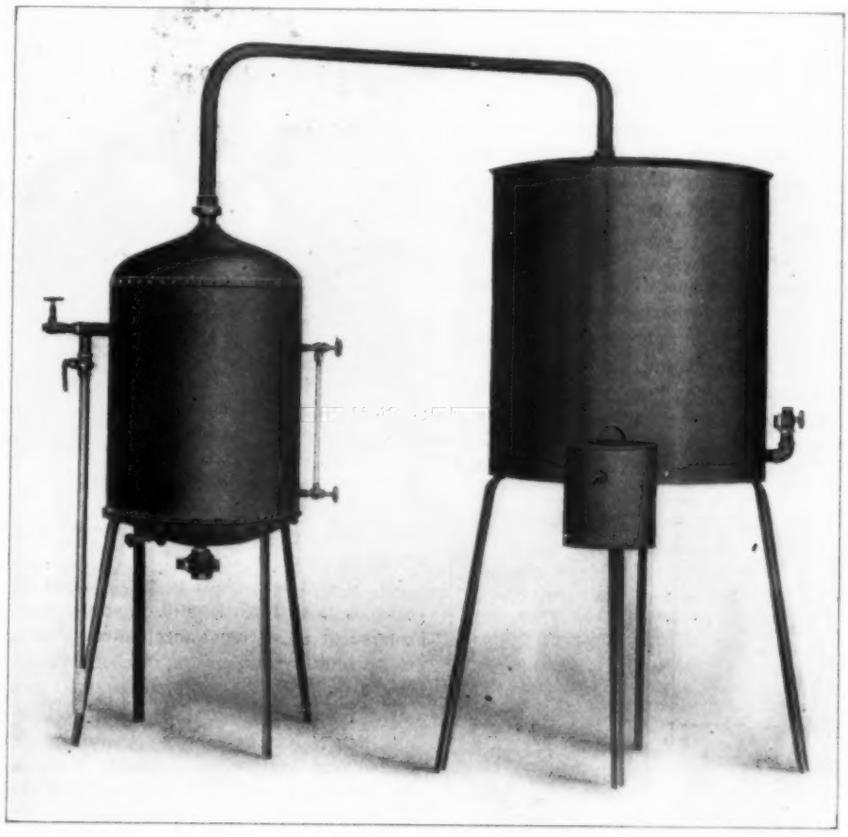
The Nippon estimates that the value of machinery imported by the new or extended companies and the army and navy of Japan for the first two months of this year amounted to $3,424,000 gold, against $1,152,000 for the corresponding period of last year.

Reclaiming Gasolene in Shops

The ever increasing price of gasolene makes it quite an object in shops using large quantities for cleaning work, as it soon becomes dirty and must be very carefully burned up, as it is exceedingly dangerous to keep around, and there seems to be practically no other way of disposing of it. The Burroughs Adding Machine Company, Detroit, Mich., use large quantities of gasolene for cleaning purposes, and some time ago ran across a distilling apparatus made by T. H. Eaton & Sons, also of Detroit, which they have had in very successful operation for some time.

It is, of course, necessary to keep fire or flame at a respectful distance from gasolene, or there are apt to be serious disturbances in the atmosphere in that vicinity, and in the distilling apparatus shown, the necessary heat is supplied by a steam coil inside the still at the left. This is built of copper with brass trimmings, and is made in several sizes, from 10 to 125 gallons. This is filled by an injector in the larger sizes, and the dirty benzine is drawn from a tank or barrel into the distilling kettle. Steam is then turned on at from 5 to 10 pounds pressure, and the distilling operation is completed in about one hour. The vapor rises and goes over into the condenser at the right, where it is cooled off, and it can be drawn out of the vessel which is known as the divider.

With this apparatus, Mr. Doughty, works manager of the Burroughs Adding Machine Company, tells us that he has been able to cut his gasolene bills in half, and that the cost of operation is no more than it formerly cost them to dispose of the dirty gasolene by having it burned in a safe and satisfactory manner.



GASOLENE STILL

Award of Medals by the American Museum of Safety Devices

Three gold medals and the diplomas of the American Museum of Safety Devices were awarded at a luncheon meeting at the Engineers Club May 25.

Dr. Tolman, director of the museum, announced that the gold medal offered by the *Scientific American* for the most meritorious invention in transportation had been awarded to the Rich Marine Fire Detecting and Extinguishing System, with an honorable mention to the Welin Quadrant Davit Company, and to the Simmen Automatic Railway Signal Company.

For the best invention in mines and mining, the gold medal offered by the Travelers' Insurance Company, of Hartford, went to the Droeger Oxygen Apparatus Company.

For motor vehicles, either on land or on the water, Francis H. Richards offered a gold medal, which was given to the Non-Explosive Safety Naphtha Con-

tainer Company with honorable mention to the Rutherford Wheel Company.

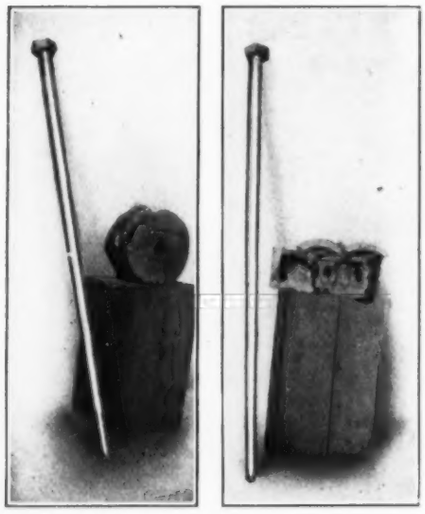
The exposition at the rooms of the Museum, 231 West 39th street, closed May 27. It has attracted technical men, railway officials, architects, and others who have expressed their satisfaction at its high character and the hope that the movement for a permanent museum may be successful. Some of the more important exhibits have been donated for that purpose. To push the work an educational committee under the chairmanship of Bishop Potter, has been organized, with Cardinal Gibbons as a member.

A Piston-head Explosion

By F. W. Collins

The two accompanying half-tones show a piston-head which exploded on April 1 in the machine shop of the Salem, Falls City and Western Railway Company at Dallas, Ore. The piston was from a sawmill engine and was undergoing repairs. At the time of the accident the piston-head had been heated in a forge preparatory to shrinking it onto the rod. Two men and a helper were standing near. Without warning the head exploded killing one of the men, seriously injuring a second and slightly injuring the third.

As shown by the half-tones, the head



AN EXPLODED PISTON HEAD

is of a common type and contains large cavities that were cored out in order to lighten it. These cavities were all connected and the holes left by the core-ends were tightly plugged. The surrounding metal was 7/8 of an inch thick or thicker. Although the cause of the explosion is not definitely known, it is believed to have been caused by the pressure of steam in this cavity, due to the presence of water which had worked its way through the shell of the piston-head while in use, or by the pressure from heated air.

I wish to give publicity to these facts in order that they may act as a warning to others engaged on similar repair work.

William Dana Ewart

William Dana Ewart, founder and former president of the Link-Belt Company, died at Rome, Italy, on Sunday, May 3, and his death will be noted with

WILLIAM DANA EWART

more than ordinary regret by those with whom he came in contact.

Mr. Ewart was born in Ohio about 56 years ago, and while still a youth gave promise of exceptional mechanical ability. His prominent invention, the malleable-iron detachable drive chain, first known as the Ewart chain, and later as the link-belt, which has become so important in agricultural and other duplicate machinery, and has contributed so largely to the great progress in the development of elevating and conveying machinery, stamped him as an inventor of high practical attainment. His drive chain has been continuously manufactured by the Ewart Manufacturing Company and exploited by the Link-Belt Machinery and Link-Belt Engineering companies, until in 1906 all three were consolidated into the Link-Belt Company, in which he retained a large interest since his retirement, his former associates carrying on the large business which was an outgrowth of his invention. Mr. Ewart was not only an inventor, but possessed strong executive ability and had the faculty of securing proper cooperation in his business organization. His health becoming impaired he retired in his early prime in the comfort that his ability brought him and went abroad in the search of his former health under more favorable climatic conditions.

Charles T. Davis

Charles T. Davis, foreman of the standard gage department of the Browne & Sharpe Manufacturing Company, with which he had been connected since its early days, died at his home in Lakewood, R. I., May 27. He was 46 years old, and is survived by a widow and four daughters, besides his father, who is 82 years old.

Mr. Davis, who has been a popular and respected resident of Lakewood for about 14 years, had been employed at the Browne & Sharpe works for the last 24 years. He went to the factory the morning of his death as usual, and during the morning was suddenly stricken ill with acute indigestion. At noon he started for home on the suburban car and got off at the Lakewood station. He walked toward his home, but was obliged to give up on the way and was taken home in a carriage, but before a physician arrived Mr. Davis was dead. He was a man of wide experience, and his work brought him in contact with many requiring the highest class of gage work. He was held in the highest esteem by all his friends, by whom his loss will be greatly felt.

Needle-threading Machine

By Robert J. Hearne

Will you allow me to correct the item at page 781 in reference to a needle-threading machine? We have a saying in the old country that "cows in Connaught have long horns" and someone has been telling the writer of the paragraph referred to, about some long horns in Switzerland. Perhaps, however, the real facts are marvelous enough to warrant drawing the long bow a "leetle" bit.

The facts are that not only are the machines in use in "a large factory in Switzerland," but in practically all factories, large and small, in Europe and America operating what are known as "hand" Swiss embroidering machines.

These latter machines are truly "hand" embroidering machines because they absolutely duplicate hand work, using a double-pointed needle, with eye in the middle which is pushed through the goods by a pair of pincers (technically Klupper) and seized on the other side of the goods by similar pincers, and returned through the goods, and so on.

The pattern and length of stitch are made by movement of the goods, which is usually in a piece 5 yards long or longer, and stretched between suitable bars. The machine operates with, say 200 needles, and is sometimes double-decked so that while the number of stitches made by any one needle per minute is not great, the aggregate is. The machines are hand and foot operated, al-

though a Jacquard device is now coming into use for power.

To return to our needle-threading machine, however, its capacity is nearer 50 needles per minute, than 1000. It takes the needles from a hopper, threads them, ties a knot, not at the end, but near the eye, cuts off the end of the thread, and sticks the needle in a long cushion, which is fed forward, to provide room for the next needle.

The next astonishing thing about these needle-threading machines is that they are sold here for $175 only, and when you figure 45 per cent. duty for Uncle Sam, expenses of shipping, and a fair profit for the seller, you can imagine that the maker doesn't get very much.

There is a great deal of hand work on the machines, and the demand is not very great; and there is some competition, as there are four makers of machines.

It looks as if the Swiss workmen must be efficient. The difference in wages alone doesn't seem to account for the low cost, and how about the ingenuity?

New York City. ROBERT J. HEARNE.

Personal*

Godfrey Engel, engineer with the Riter, Conley Manufacturing Company, has recently become engineer of construction at Fort Collins, Colo.

D. E. Jackson, formerly of Pittsburg, has joined his brother's firm of E. S. Jackson & Co., Chicago agency for the Firth-Sterling Steel Company.

Warren E. Thompson has recently severed his connection with the Union Twist Drill Company and is now employed as head inspector at the Boston Gear Works.

William Freundel, for the past thirteen years foreman of the machine shop of the F. R. Plumb's Edge Tool and Hammer Works, Frankford, Philadelphia, Penn., has resigned and is succeeded by Fred J. Ramsey.

John K. Murphy, until recently assistant superintendent of the Oakville Company, Waterbury, Conn., has accepted a position in the cartridge department of the Winchester Repeating Arms Company, New Haven, Conn.

Wm. E. Dodds, formerly manager of the steam engineering department of Allis-Chalmers Company, has recently assumed the position of general manager of the Standard Cast Iron Pipe and Foundry Company, Bristol, Penn.

Arthur S. Hawks, formerly designer with the Westinghouse Machine Company, has become engineer for the new power department of the Bethlehem Steel Company, organized for the manufacture of power producing machinery.

A. M. Levin has reopened an office as consulting engineer and power plant expert in the Monadnock building, Chicago, Ill. Mr. Levin has been engaged by the Minneapolis Steel and Machinery Company for the past two years.

Thomas B. Whitted who has been connected with the General Electric and Westinghouse interests for the past twelve years has established the firm of Thomas B. Whitted & Co., machinery and contracting engineers, at Charlotte, North Carolina.

*Items for this column are solicited.

Business Items

The New York offices of the Warner & Swasey Company, Cleveland, O., have been moved to the 24th floor of the Singer building.

The Watson-Stillman Company has moved its New York office to the Hudson Terminal buildings, 50 Church street.

Charles Engelhard, agent for Heraeus Lechatellier pyrometer in this country, has removed from 39 Cortlandt street, to more commodious offices at 50 Church street.

The offices of the Lea Equipment Company, makers of cold saws, were not seriously damaged by the fire at 136 Liberty street, New York, May 24. This company is now doing business in offices in another part of the building.

Trade Catalogs

Estep & Dolan, Sandwich, Ill. Catalog of hand-bending tools. Illustrated, 16 pages, 6x9 inches, paper.

Edwin Burhorn, 71 Wall street, New York. Catalog of cooling towers. Illustrated, 48 pages, 6x8 inches, paper.

The Reynolds Machine Company, Rock Island, Ill. Circular illustrating and describing automatic screw-driving machines.

American Blower Company, Detroit, Mich. Catalog No. 232, describing vertical self-oiling steam engines. Illustrated, 64 pages, 7x9 inches, paper.

Topping Brothers, 122 Chambers street, New York. Catalog of Burrows ball-bearing jacks, track drills, tool grinders, etc. Illustrated, 24 pages, 5x8 inches, paper.

The Park Drop Forge Company, Cleveland, Ohio. Pamphlet entitled "Henry Cort and the Invention of Puddling and Rolling," which is No. 3 of Short Stories About Steel. Illustrated, 4¼x6½ inches.

Lunkenheimer Company, Cincinnati, Ohio. 1908 catalog of valves, gages, lubricators, oil pumps, grease cups, etc., which the company will be pleased to send to anyone interested. Illustrated, 564 pages, 5x7 inches, cloth.

Business Opportunities

The Lewistown (Penn.) Foundry and Machine Company will enlarge the capacity of its plant.

W. A. Erwin, Franklinton, La., will establish a plant for the manufacture of boxes and crates.

The Bedford Can Company, Bedford City, Va., has been incorporated to manufacture cans.

The plant of the Wintermeyer Box Company, Chicago, was destroyed by fire. Loss $400,000.

The plant of the Sendelbach Wheel Company, East St. Louis, Ill., was burned. Loss $110,000.

The Acme Steel and Malleable Iron Company, Buffalo, N. Y., has purchased site for an enlarged plant.

The plant of the New England Box Company, at Ashuelot, N. H., was burned. Loss, $30,000. It will be rebuilt.

A charter has been granted to the Decherd (Tenn.) Canning Company. A canning factory will be established.

It is reported that the Northern Pacific Railroad will soon let contract for a new roundhouse at Sandpoint, Idaho.

The Midland (Penn.) Steel Company has plans completed for the erection of two additional blast furnaces.

The Campbell Automatic Gas Burner Company, Portland, Wash., is having plans prepared for a $60,000 factory.

The Camden Mill Company, Camden, Ark., will erect a factory for the manufacture of sash, doors and blinds.

Fire destroyed the plant of the Maryland Metallic Bed Company, Baltimore, Md., causing a loss of about $50,000.

Fire destroyed the planing mill of the S. N. Ford Lumber Company, Mansfield, Ohio, causing a loss of about $75,000.

Messrs. J. F. and J. J. Whalen, Burlington, Vt., are erecting a factory for the manufacture of paper tubes and boxes.

The United States Printing Company, Norwood, Cincinnati, Ohio, will erect an additional building to cost $200,000.

The Athens (Ga.) Mattress and Spring Bed Company will install machinery to manufacture iron beds and bed springs.

M. J. Cameron and Sons, Albany, Ore., are erecting a planing mill which will also be equipped with woodworking machinery.

The Stover Engine Works, Freeport, Ill., is erecting an addition to be used as a light machine shop and stock room.

A foundry building will be erected for Charles F. Schaeffer at Thirty-fifth street and Gray's Ferry Road, Philadelphia, Pa.

The Marion (Ohio) Steam Shovel Company will build an addition to be fitted with furnaces and machinery for making steel.

The Delphos (Ohio) Can Company is erecting an addition to the galvanized iron department and making other improvements.

The Niles (Ohio) Iron and Steel Company will build an addition to the plant and will expend about $75,000 for improvements.

The Cramp Dry Dock Company, Norfolk, Va., will establish complete shop for ship-repair plant to cost $500,000. J. A. C. Groner, engineer in charge.

The Hartford (Ala.) Sash and Door Manufacturing Company is being incorporated by E. C. Boswell, H. A. Powell, etc. Plant will be erected,

The Union Cotton Mills, Greenville, S. C., contemplates building a machine shop and will be in the market for equipment. J. C. West is master mechanic.

The Canadian Pacific Railway Company has decided to erect a machine shop in connection with other building in Ssaskatoon, Sask. W. E. Woodhouse, Calgary, Alta., is master mechanic.

The Fort Worth & Denver City Railway will rebuild machine, blacksmith and boiler shops recently burned at Childress, Texas, at a loss of $200,000. H. A. Gausewitz, Childress, superintendent.

The Isthmian Canal Commission, Washington, D. C., will receive bids to 10:30 a. m. June 15, 1908, for hand planer and jointer, band saw, floor grinder, chain blocks, truck springs, chain, steel, iron, boiler tubes, wire, screws, shovels, bridge reamers, valves, steam and water gages, oil and grease cups, etc., as per Circular No. 443.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids on June 9th for the following: 600 dozen hack-saw blades (schedule 1274), twist drills

(schedule 1273), emery wheels (schedule 1265), tool holders (schedule 1273). Bids will be opened on June 16th for the following: Lathe and drill chucks, chain hoists, engine lathe, milling machine, hand-screw machine, planer tool, planing attachment, etc. (schedule 1269).

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

Perfect factory space to let. Robt. J. Emory & Co., Newark, N. J.

If you use small gears in large quantities, write Berry & Parker, Erie, Pa.

Steel case hardened; modern methods. Boston Gear Works, Norfolk Downs, Mass.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—Good second-hand boring mill, 24" swing. Give full description and price. Box 170, AMERICAN MACHINIST.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

We are anxious to procure copies of August 25, 1904, issues of AMERICAN MACHINIST. Address, with price, Box 144, AMER. MACHINIST.

We are equipped to turn out twice the number of gears used on our own work, can we do yours to fill in? Samuel M. Langston, Camden, N. J.

Wanted—Foundry and machine shop want orders for brass castings in quantities; also speed and monitor lathe work. Box 182, AMERICAN MACHINIST.

Valuable United States patent for sale outright or on royalty. The latest continuous blueprint machine. B. J. Hall, 41 Castelnau, Barnes, London, England.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—Some good specialty or new type of machine tool to manufacture in a modern plant, equipped with high grade tools and with ample capital. Box 151, AMER. MACHINIST.

Lathe and machine work of every description, patterns, gear cutting, screw machine work, iron, brass and aluminum castings. The Sipp Electric and Machine Co., Paterson, N. J

Engineer, German-American, practical, with office at large German city, is wanting to represent first-class machine-tool builders in Germany and Austria. Can furnish A-1 references. Box 181, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Machinists take notice. Purchase castings and blueprints of high-grade gasolene motor, of world-wide reputation and at a profitable business. Write today. F. P. Conrad, 242 Freeport St., Harrison Sq., Boston.

We are looking about for some article or articles to take over. If you have something of merit, we will take up the financing, manufacturing and sale of it on any fair basis. "H. W. D.," AMERICAN MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Manufacturers of high-grade automatic or semi-automatic machinery for the rapid production of small steel screws (from 1 to 5 millimeters) and other parts, for small precision machines, are requested to send catalogs and quote prices to Camillo Olivetti, Civil and Electrical Engineer, Ivrea, Italy.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

MASSACHUSETTS

Experienced designer on automatic and special machinery. First-class references. Box 187, AMERICAN MACHINIST.

Wanted—Position as designing draftsman by a Swedish technical graduate; 27 years of age, with three years' experience in United States. Box 119, AMERICAN MACHINIST.

Position as superintendent or manager, fifteen years' experience as superintendent on high grade work. An expert on interchangeable work, also on the most approved machine shop, foundry and boiler shop methods. Am a good organizer and can handle men and machinery to best advantage. Box 185, AM. MACH.

Superintendent or general foreman, good executive, hustler, up-to-date, money-saving methods, technical and practical man, ten years' experience, desires position at once and will not refuse any reasonable offer. Any part of the United States. Can furnish best of references. Box 176, AMERICAN MACHINIST.

NEW JERSEY

Mechanical draftsman wishes position. Address Box 175, AMERICAN MACHINIST.

NEW YORK

Superintendent or manager, twenty years' experience foundry and machine business. Mechanical and executive ability to make plant pay. Box 179, AMERICAN MACHINIST.

Responsible position wanted by expert mechanic, designer of special machinery and tools. Theoretical and practical; salary $200 per month. Box 178, AMERICAN MACHINIST.

Wanted—By first-class mechanic, well up in modern tool room and machine shop practice, position as tool room foreman or general machine shop foreman. Can furnish the best of references. Box 183, AMERICAN MACHINIST.

Wanted—A position as shop superintendent or assistant general manager by a graduate mechanical engineer. At present employed in a similar position by a large manufacturing plant. Will state reason, to responsible parties, for desiring to change. A-1 references. Address Box 177, AMERICAN MACHINIST.

PENNSYLVANIA

Toolmaker, up-to-date, used to close work, wide experience; also first-class on experiments, can handle men, wants position. Box 186, AMERICAN MACHINIST.

WISCONSIN

Position as factory manager or general superintendent by thoroughly practical shop man. Interchangeable manufacture. Competent to take entire charge of factory and produce results. Replies desired only from those who want an A-1 man and who are willing to pay liberally therefor. Address Box 150, AMERICAN MACH.

FOREIGN

Master mechanic; American; age 37; responsible man with large and varied experience manufacturing, erecting and maintaining; successful in producing high grade work at lowest cost; at liberty July 1; Pacific Coast States only; state salary. B. Nilius, Master Mechanic, Rio Blanco, Peru, via Lima

Help Wanted

Classification indicates present address of advertiser, nothing else.

DISTRICT OF COLUMBIA

Wanted—Ship draftsmen. Pay $2.00 to $5.04 per diem. An examination will be held July 14, 1908, for the purpose of establishing an eligible register for ship draftsmen and assistant ship draftsmen. For application and further information address, President of the Examining Board of Ship Draftsmen, Bureau of Construction and Repair, Navy Department, Washington, D. C.

MASSACHUSETTS

Wanted—We wish to add to our force, foremen, assembling and machine hands. Do not apply unless you have had experience in the manufacturing of monkey wrenches and similar work. Box 167, AMERICAN MACHINIST.

NEW YORK

Wanted—Experienced toolmakers; give age, references and wages expected. Box 180, AMERICAN MACHINIST.

OHIO

Wanted—Draftsman to design machinery. Give age and experience in detail. Address Box 65, Station B, Cincinnati, Ohio.

RHODE ISLAND

Wanted—A man with an all-around repair experience to take position as master mechanic in large manufacturing establishment in New England. Experience in textile work preferred. State education, experience, age, nationality, and references. Box 174, AMERICAN MACHINIST.

For Sale

Patent for a motorcycle engine for sale outright or on royalty. Box 184, AMER. MACHINIST.

For Sale—Well equipped general machine shop in New Jersey; employing 15 to 20 hands; good reason for selling. P. O. Box 1216, New York City.

For Sale—One second-hand Uehling Steinbart & Company pneumatic pyrometer complete, with recording gage. Box 140, AMERICAN MACHINIST.

Alphabetical Index to Advertisers

	PAGE
Abrasive Material Co.	151
Acme Machinery Co.	104
Adams Co.	108
Albro Clem Elevator Co.	144
Almond Mfg. Co., T. R.	136
Alteneder & Son, Theo.	155
American Emery Wheel Wks.	151
American Gas Furnace Co.	118
American Pulley Co.	74
American School of Correspondence	103
American Tool & Machine Co.	132
American Tool Works Co., 8 and	162
American Tube and Stamping Co.	165
American Watch Tool Co.	109
American Wood Working Machinery Co.	83
Ames & Co., B. C.	148
Armstrong-Blum Mfg. Co.	148
Armstrong Bros. Tool Co.	96
Automatic Machine Co.	127
Baker Bros.	120
Bardons & Oliver	134
Barnes Co., W. F. & John	14
Barnett, G. & H.	40
Bath Grinder Co., Inc.	93
Baush Machine Tool Co. 3d cover	
Bay State Stamping Co.	146
Beaman & Smith Co. 15 and	136
Becker-Brainard Milling Machine Co.	23
Bemis & Call Hdw. & Tool Co.	75
Bertsch & Co.	134
Besly & Co., Charles H.	91
Bethlehem Foundry and Machine Co.	130
Bickford Drill & Tool Co.	10
Bignall & Keeler Mfg. Co.	116
Bilgram, Hugo	142
Billings & Spencer Co.	154
Birdsboro Steel Foundry and Machine Co.	120
Blaisdell Machinery Co.	165
Blanchard Machine Co.	104
Bliss Co., E. W.	25
Blount Co., J. G.	150
Boston Gear Works	145
Boston Saw and Tool Co.	149
Boulets Fine Tool Works	151
Bowsher & Co., N. P.	153
Boynton & Plummer	125
Bradford Machine Tool Co.	5
Bradley & Son, C. C.	118
Bristol Co. 4th cover	
Brown & Co., R. H.	137
Brown & Sharpe Mfg. Co., 55 and 4th cover	
Brown Hoisting Mchry. Co.	74
Brubaker & Bros., W. L.	148
Buffalo Gear & Pattern Wks.	146
Builders' Iron Foundry	40
Bullard Mach. Tool Co.	39
Burke Electric Co.	159
Burk Mchry. Co.	73
Burr & Son, John T.	133
Bury Compressor Wks.	165
Byram & Co., Inc.	148
C & C Electric Co.	158
Caldwell & Son Co., H. W.	119
Cammel Laird & Co.	139
Carborundum Co.	9
Card Mfg. Co., S. W.	34
Carpenter Tap & Die Co., J. M.	77
Carver File Co.	154
Case Mfg. Co.	74
Cell Drier Machine Co.	141
Chadwick & Trefethen	151
Chambersburg Eng'ing Co.	123
Champion Tool Works Co.	123
Chicago Flexible Shaft Co.	77
Chicago Machine Tool Co.	107
Chicago Raw Hide Mfg. Co.	142
C. I. F. Co.	121
Cincinnati Chuck Co.	136
Cincinnati Elec. Tool Co.	83
Cincinnati Lathe & Tool Co.	131
Cincinnati Machine Tool Co.	24
Cincinnati Milling Mach. Co.	7
Cincinnati Planer Co.	6

PAGE

Cincinnati Shaper Co.....163
Clark Cast Steel Cement Co.139
Clark, Jr., Electric Co., Inc., Jas. 159
Clayton Air Compressor Wks.165
Cleveland Auto Mach. Co.... 18
Cleveland Crane & Car Co... 74
Cleveland Planer Works.....111
Cleveland Stone Co.....151
Cleveland Twist Drill Co., 4th cover
Cling-Surface Co.....134
Clough, R. M.....133
Clum & Atkinson.....139
Coates Clipper Mfg. Co.....129
Coes Wrench Co.....26 and 27
Colburn Machine Tool Co.... 76
Colcord Machinery Co., W. R.160
Consolidated Press and Tool Co. 101
Cook Co., Asa S.....148
Crescent Forgings Co.....133
Crocker-Wheeler Co.....158
Crosby Steam Gage & Valve Co. 159
Cullinan Wheel Co.....148
Curtis & Curtis Co.....149
Cushman Chuck Co.....136

Davis Machine Co., W. P....162
Desmond-Stephan Mfg. Co...152
Detrick & Harvey Mach. Co..149
Diamond Chain & Mfg. Co...102
Diamond Saw and Stamping Works 119
Dickinson, Thos. L.....40
Dill Slotter People.....134
Dixon Crucible Co., Jos.....120
Dreses Machine Tool Co..... 80
Dunbar Bros. Co.....134

Earle Gear & Mach. Co.....146
Eastern Machinery Co.....146
Eberhardt Bros. Mach. Co...146
Eck Dynamo & Motor Co....159
Electric Welding Products Co.106
Elliott Chemical Works.....146
Elmes Engineering Works, Chas. F..... 78
Errington, F. A.....137
Estep & Dolan.....149
Evans Friction Cone Co.....131
Excelsior Needle Co.....114

Farrel Fdry. & Mach. Co....139
Fawcus Machine Co.....144
Fay Machine Tool Co.....109
Fay & Scott.....122
Fellows Gear Shaper Co..... 61
Felton, Sibley & Co.....130
Ferracute Machine Co.....122
Firth-Sterling Steel Co.....140
Fitchburg Machine Works.... 31
Flather Planer Co., Mark...115
Foote Bros. Gear & Mach. Co. 144
Foote-Burt Co., The.....113
Fosdick Machine Tool Co.... 16
Franklin Mfg. Co., H. H....141
Franklin Portable Crane & Hoist Co..... 75
Fulton Machine & Vise Co...147

Gang Co., Wm. E.....148
Gardner Machine Co.....151
Garvin Machine Co..... 86
Gem Mfg. Co..... 79
General Electric Co.....156
Geometric Tool Co..... 33
Gisholt Machine Co.....106
Gleason Works.....4th cover
Globe Mach. & Stamp. Co...132
Goldschmidt Thermit Co.....141
Gorton Machine Co., Geo....124
Gould & Eberhardt..... 72
Graham Mfg. Co.....147
Grant Gear Works.....142
Grant Mfg. & Mach. Co..... 77
Gray Co., G. A..... 28
Greaves, Klusman & Co....133

PAGE

Hammacher, Schlemmer Co.. 65
Hardinge Bros.....105
Harrison & Knight Mfg. Co..117
Harrington, Son & Co., Edw.126
Hart & Cooley Co.....118
Hart Mfg. Co.....123
Hendey Machine Co..... 63
Henry & Wright Mfg. Co.... 81
Hilbert Machine Co.....166
Hill, Clarke & Co., Inc.....161
Hill Publishing Co.....162
Hilsey-Wolf Machine Co..... 73
Hoefer Mfg. Co.....129
Hoggson & Pettis Mfg. Co...137
Horsburgh & Scott Co.....144
Horton & Son Co., E.....136
Howson & Howson.....148
Hunt Co., Robt. W.....149
Hurlbut-Rogers Machine Co..114

Independent Pneumatic Tool Co. 1
Industrial Oxygen Co.....139
Industrial Law League.....133
Ingersoll Milling Machine Co. 33
International Correspondence Schools 101
Iroquois Machine Co.....110

Jacobs Mfg. Co.....137
Jantz & Leist Elec. Co.....159
Johnson Machine Co., Carlyle.110
Jones & Lamson Mach. Co., 12, 13 and 40
Juengst & Sons, George.....121

Kearney & Trecker Co..... 94
Kelly Co., R. A.....153
Kempsmith Mfg. Co..... 22
Kern Machine Tool Co..... 76
Keuffel & Esser Co.....154
Knight Mchry. Co., W. B....133
Kolesch & Co.....155
Krieger Tool & Mfg. Co.....133

L. & D. Co..... 75
Lamson Consol. S. S. Co.... 74
Landis Machine Co.....131
Landis Tool Co..... 57
Lang Co., G. R.....132
Lapointe Machine Tool Co...132
Lea Equipment Co.....122
LeBlond Machine Tool Co., R. K.....63, 69 and 4th cover
Leonard Mfg. Co.....153
Link Belt Co..... 84
Lodge & Shipley Machine Tool Co. 4
Long & Allstatter Co.....132
Lucas Machine Tool Co.....164
Lufkin Rule Co.....155
Lumen Bearing Co.....138
Lunkenheimer Co.....116
Lyon Metallic Mfg. Co.....153

Machine Screw Products Co..148
Manning, Maxwell & Moore, Inc. 74
Manufacturing Equipment and Engineering Co.....119
Manville Bros. Co..... 79
Manville Machine Co., E. J.. 77
Maris Bros..... 74
Marshall & Huschart Mch. Co.162
Marston & Co., J. M.....148
Massachusetts Saw Works... 79
McCabe, J. J.....32 and 160
McInnes Steel Co.....139
Mechanics Machine Co.....130
Merrell Mfg. Co.....132
Merritt, Jos.....140
Merritt & Co.....146
Metal Hardening Solution Co.138
Millers Falls Co.....132
Milton Mfg. Co.....126
Mitts & Merrill.....117
Moline Tool Co.....134
Monarch Emery & Cor. Wheel Co. 151
Morris Foundry Co., John B.112

PAGE

Morse Chain Co.....100
Morse Twist Drill & Mach. Co. 59
Morse, Williams & Co.....146
Morton Mfg. Co.....113
Mossberg Wrench Co.....153
Motch & Merryweather Machinery Co.....160
Mueller Mach. Tool Co.....133
Mummert, Wolf & Dixon Co.. 76
Mutual Mach. Co.....146

Nash Co., Geo.....141
National-Acme Mfg. Co.....106
National Machine Co.....132
National Machinery Co.....105
New Britain Machine Co....115
New Haven Mfg. Co.....108
New Process Raw Hide Co...143
Newton Machine Tool Works, Inc. 11
Nicholls, Wm. S.....74
Nicholson & Co., W. H..... 88
Nicholson File Co..... 17
Niles-Bement-Pond Co., 35, 36, 37, 38 and 161
Northern Electrical Mfg. Co..158
Northern Engineering Works. 74
Norton Co..... 71
Norton Grinding Co..... 70
Nuttall Co., R. D.....142

Obermayer Co., S.....138
Oesterlein Machine Co.....116
O. K. Tool Holder Co.....149
Owen Machine Tool Co..... 22

Parker, C. L.....148
Parker Co., Chas.....147
Pawling & Harnischfeger..... 74
Paxson Co., J. W.....130
Philadelphia Bourse.....116
Philadelphia Gear Works....142
Pittsburg Emery Wheel Co.. 69
Pittsburg Auto. Vise & Tool Co., Ltd.....147
Plunket, J. E.....146
Potter & Johnston Mach. Co., 20 and 21
Powell Tool Co.....149
Powell Co., Wm.....148
Pratt Chuck Co.....135
Pratt & Whitney Co....2 and 3
Prentice Bros. Co..... 29
Prentiss Tool & Supply Co..160
Prentiss Vise Co.....146
Prosser & Sons, Thos.....138

Q. C. Machine Tool Co.....117

Reed Co., F. E..... 89
Reed Mfg. Co.....147
Reichhelm & Co., E. P.....130
Remington Tool and Mach. Co. 78
Risdon Tool Works.....149
Rivett Lathe Mfg. Co....3d cover
Robbins Machine Co.....131
Robinson Tool Works.....131
Rockford Drilling Mach. Co..126
Rock Island Tool Co.....147
Rockwood Mfg. Co..... 75
Rogers & Hubbard Co.....138
Rogers Wks., John M..... 78
Root Co., C. J.....149
Roth Bros. & Co.....157
Royersford Fdry. & Mach. Co.134

Safety Emery Wheel Co.....150
Sames, C. M.....134
Saunders Sons, D.....153
Sawyer Gear Wks.....142
Sawyer Tool Mfg. Co.....155
Schellenbach & Hunt Tool Co.154
Schieren Co., Chas. A..... 82
Schmitz, August.....130
Schuchardt & Schutte..... 73
Schumacher & Boye..... 9
Schwerdtle Stamp Co.....149
Sebastian Lathe Co..... 25
Sellers & Co., Inc., Wm..... 30

PAGE

Seneca Falls Mfg. Co..... 80
Shepard Electric Crane and Hoist Co..... 75
Shultz Belting Co.....100
Sibley Mch. Tool Co.....124
Simonds Mfg. Co..... 95
Skinner Chuck Co.....136
Slate Machine Co., Dwight..131
Sloan & Chace Mfg. Co., Ltd. 65
Slocomb Co., J. T..... 97
Smith, Chas. F.....149
Smith Countershaft Co..... 31
Smith & Mills.....148
Smith Co., Wm. J..... 99
Spacke Mach. Co., F. W.....165
Springfield Mach. Tool Co... 15
Standard Connecting Rod Co.122
Standard Engineering Wks..159
Standard Gauge Steel Co....119
Standard Tool Co..... 90
Stark Tool Co.....130
Starrett Co., L. S..... 92
Stevens, Frederick S.....138
Stoever Fdry. & Mfg. Co....154
Stow Mfg. Co.....157
Sturtevant Co., B. F..... 24
Swaine Mfg. Co., Fred J.... 78

Tabor Mfg. Co.....118
Taylor & Fenn Co.....125
Taylor-Wilson Mfg. Co.....142
Technical Supply Co.....155
Tindel-Morris Co..... 83
Toledo Machine & Tool Co...117
Toomey, Frank.....160
Triumph Electric Co.....157
Tudor Mfg. Co.....128
Turner Brass Works.....146
Turner Machine Co.....131

Underwood & Co., H. B.....106
Union Mfg. Co.....137
Union Twist Drill Co..... 67
Universal Drafting Mach. Co.155
Universal Machine Screw Co.121
U. S. Electrical Tool Co.... 87

Van Dorn & Dutton Co.....142
Van Dorn Elec. & Mfg. Co..157
Vandyck Churchill Co..... 79
Veeder Mfg. Co.....148
Vitrified Wheel Co.....152
Von Wyck Mach. Tool Co...112

Wagner Elec. Mfg. Co.....159
Walcott & Wood Mach. Tool Co. 103
Wallace Supply Co.....148
Waltham Machine Wks.....130
Walthan Watch Tool Co....153
Ward & Sons, Edgar T.....138
Warner & Swasey Co.....164
Warner Instrument Co.....131
Waterbury Farrel Fdry. & Mach. Co..... 76
Watson-Stillman Co.....127
Wellman Co.....149
Western Tool Mfg. Co..... 83
West Haven Mfg. Co.....115
Westmacott Gas Furnace Co.159
Whitcomb - Blaisdell Machine Tool Co..... 19
Whitman & Barnes Mfg. Co..111
Whitney Mfg. Co..... 53
Whiton Machine Co., D. E...135
Wiley & Russell Mfg. Co.....107
Williams & Co., J. H.....154
Williams Foundry and Machine Co.....121
Williamson Vise Co.....147
Wilmarth & Morman Co.....152
Winkley Co.....153
Wood Turret Lathe Co..... 98
Woodward & Powell Planer Co. 81
Worcester Machine Screw Co.149
Wormer Machinery Co., C. C.162
Wrigley Co., Thos.....151
Wyke & Co., J.....149

Yale & Towne Mfg. Co.....102

Classified Index to Articles Advertised

Abrasive Materials

Abrasive Material Co., Phila., Pa.
American Emery Wheel Co., Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Dickinson, Thos. L., New York.
Monarch Emery and Corundum Wheel Co., Camden, N. J.
Norton Co., Worcester, Mass.
Pittsburg Emery Wheel Co., Pittsburg, Pa.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Agents, Foreign Machinery

C. I. F. Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

See Grinding Wheels.

Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Cleveland Twist Drill Co., Cleveland, O.

Arbors—*Continued.*

Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Balancing Ways

Bowsher Co., N. P., South Bend, Ind.

Barrels, Steel

Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Globe Machine & Stamping Co., Cleveland, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Krieger Tool & Mfg. Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs Mass.
Hyatt Roller Bearing Co., Harrison, N. J.
Iriquois Mach. Co., Providence, R. I.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N.Y.
Desmond-Stephan Mfg. Co., Urbana, Ohio.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Fasteners

Bristol Co., Waterbury, Conn.

Belt Filler

Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belt Shifters

The L. & D. Co., Boston, Mass.

Belting, Leather

Chicago Raw Hide Mfg. Co., Chicago, Ill.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Benches, Work

Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machines, Plate

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Toledo Machine & Tool Co., Toledo, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machines, Power

Bertsch & Co., Cambridge City, Ind.
Bethlehem Fdry. & Machine Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Swaine Mfg. Co., Fred. J., St. Louis, Mo.

Bending Tools, Hand

Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

Blanks, Nuts and Screw

Electric Welding Products Co., Cleveland, O.

Blocks, Chains

See Hoists, Hand.

Blocks, Die

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Blowers

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Brothers & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

Keuffel & Esser Co., Hoboken, N. J.

Blue Print Paper

Keuffel & Esser Co., Hoboken, N. J.

Bolt and Nut Machinery

Acme Mchry. Co., Cleveland, O.
Boynton & Plummer, Worcester, Mass.
Davis Machine Co., W. P., Rochester, N. Y.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Manville Mach. Co., E. J., Waterbury, Conn.
McCabe, J. J., New York.
Milton Mfg. Co., Milton, Pa.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National-Acme Mfg. Co., Cleveland, O.

Bolt and Nut Machinery —*Continued.*

National Machinery Co., Tiffin, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang & Co., G. R., Meadville, Pa.

Bolts and Nuts

Electric Welding Products Co., Cleveland, Ohio.
Milton Mfg. Co., Milton, Pa.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
Sames, Chas. M., Jersey City, N. J.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, O.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Works Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
McCabe, J. J., New York.
Mitts & Merrill, Saginaw, Mich.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Krieger Tool & Mfg. Co., Chicago Ill.
Western Tool & Mfg. Co., Springfield, O.

Boxes, Tote

Lyon Metallic Mfg. Co., Aurora, Ill.

Box Tools, Roughing

Bardons & Oliver, Cleveland, O

Brazing

Industrial Oxygen Co., New York.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

Bliss Co., E. W., Brooklyn, N. Y.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Toledo Machine & Tool Co., Toledo, Ohio.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers

Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum

See Grinding Wheels.

Carborundum Paper and Cloth

Carborundum Co., Niagara Falls, N. Y.

Case-Hardening

American Gas Furnace Co., New York.
Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Castings, Brass and Bronze

Clum & Atkinson, Rochester, N. Y.
Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded

Berry & Parker, Erie, Pa.
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Frdy. & Mach. Co., Birdsboro, Pa.
Cell Drier Machine Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Taylor & Fenn Co., Hartford, Ct.

Castings, Steel

Birdsboro Steel Fdry. & Mach Co., Birdsboro, Mass.
Cammel, Laird & Co., New York.
Krupp (Thos. Prosser & Son), New York.

Cast Iron Brazing

Industrial Oxygen Co., New York.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.
Obermayer & Co., S., Cincinnati, O.

Centering Machines

Hendey Mach. Co., Torrington, Conn.
McCabe, J. J., New York.
National Machine Co., Hartford, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Fay & Scott, Dexter, Me.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Boston Gear Works, Norfolk Downs, Mass.
Cullman Wheel Co., Chicago, Ill.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Conn.

Chucking Machines

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Lancaster Knife and Machine Wks., Lancaster, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Whitney Mfg. Co., Hartford, Conn.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cincinnati Chuck Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Harrington & Son Co., Edwin, Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.

Circuit Breakers

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Hammacher, Schlemmer & Co., New York.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams & Co., J. H., Brooklyn, N.Y.

Clocks, Watchman's

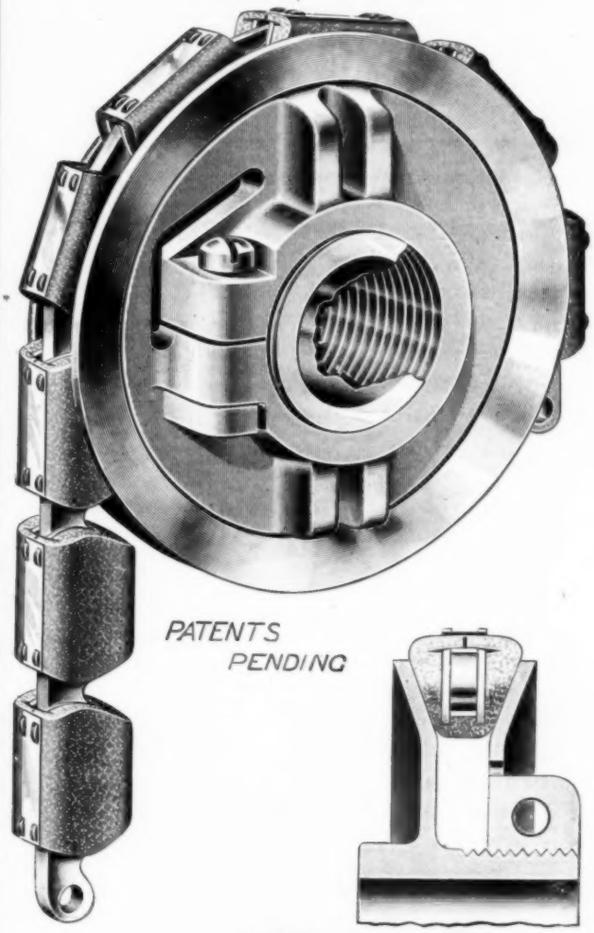
Hardinge Bros., Chicago, Ill.

Clutches, Friction

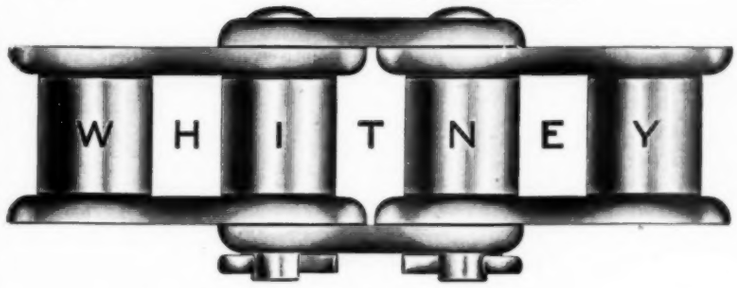
American Tool & Machine Co., Boston, Mass.
Bliss Co., E. W., Brooklyn, N. Y.
Caldwell, Son & Co., W. H., Chicago, Ill.

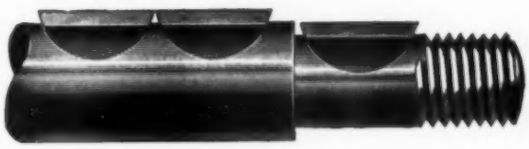
New "Whitney" Chain Belt

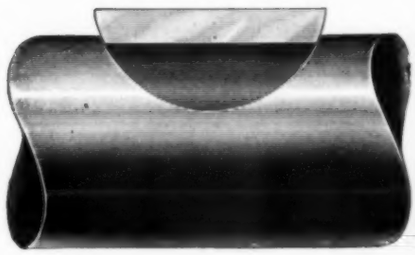
For Cooling Fans, Oiling Devices, Motorcycles, Etc.



PATENTS PENDING







If you are not taking advantage of the Woodruff Patent System of Keying it will pay you to investigate.

Better results and a great saving in cost.

We carry 95 regular sizes of Keys and Cutters in stock for immediate delivery.

"Whitney" Patent Cotter Detachable Roller Chains

Made a fine record in the Briarcliff Road Race.

THE WHITNEY MFG. COMPANY,
Hartford, Conn.

New York City, May 2, 1908.

Gentlemen—The uniform strength of an automobile driving chain is one of the important requisites in a speed contest.

The "Whitney" Chains which formed a part of the equipment on our three "Stearns" Cars in the recent Briarcliff Stock Car Road Race, showed their superiority by coming through this exceptionally difficult contest without the slightest evidence of the terrific strain which they had undergone. Our "Stearns" Cars made an exceptional showing in this race, and we attribute our success in no small degree to the entire absence of chain trouble.

Our experience in previous contests has taught us that a faulty chain can cause a lot of trouble.

We therefore take this opportunity to express the satisfaction which we feel at the manner in which "Whitney" Chains demonstrated their worth.

Yours very truly,
WYCKOFF, CHURCH & PARTRIDGE,
By C. F. Wyckoff, President.

THE WHITNEY MFG. COMPANY, Hartford, Conn.

Clutches, Friction—*Cont.*
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Williams Foundry & Machine Co., Akron, Ohio.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Compound, Core
Obermayer Co., S., Cincinnati, O.

Compound, Pipe Joint
Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Machine Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Blaisdell Machinery Co., Bradford, Pa.
Ingersoll-Rand Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Electric Welding Products Co., Cleveland, Ohio.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Cambridge, Mass.
Cell Drier Mach. Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Manville Bros. Co., Waterbury, Conn.
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Conn.

Controllers and Starters, Electric Motor
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic
Lamson Consolidated Store Service Co., Boston, Mass.
Link-Belt Co., Philadelphia, Pa.

Coping Machines
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum
See Grinding Wheels.

Cotters
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Revolution
Root Co., C. J., Bristol, Conn.
Schuchardt & Schutte, New York.
Veeder Mfg. Co., Hartford, Conn.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders Iron Foundry, Providence, R. I.
Coates Clipper Mfg. Co., Worcester, Mass.

Countershafts—*Continued.*
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.

Couplings
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Williams Fdry. & Mach. Co., Akron, Ohio.

Cranes
Brown Hoisting Mach. Co., Cleveland, O.
Byram & Co., Inc., Detroit, Mich.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Franklin Port. Crane and Hoist Co., Franklin, Pa.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Krupp (Thos. Prosser & Son), New York.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Byram & Co., Inc., Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups, Grease
Lunkenheimer Co., Cincinnati, O.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hurlburt-Rogers Mach. Co., South Sudbury, Mass.
McCabe, J. J., New York.
Newton Mach. Tool Wks., Inc., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Fitchburg Machine Works, Fitchburg, Mass.
Krieger Tool & Mfg. Co., Chicago, Ill.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.

Diamond Tools
American Emery Wheel Co., Providence, R. I.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co., Cleveland, O.
Manville Bros. Co., Waterbury, Conn.
Risdon Tool Works, Waterbury, Conn.
Swain Mfg. Co., Fred. J., St. Louis, Mo.
Toledo Machine & Tool Co., Toledo, Ohio.

Dies, Sub-Press
Risdon Tool Works, Waterbury, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., Hoboken, N. J.
Kolesch & Co., New York.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., Hoboken, N. J.
Kolesch & Co., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Boiler
American Tool Works Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Flather Planer Co., Mark, Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschardt Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Moline Tool Co., Moline, Ill.
National Machine Co., Hartford, Conn.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Conn.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Works Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Kilbert Mach. Co., Cincinnati, Ohio.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O.